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CONTENTS

	Page
Scientific and Technical Books in Great Britain	677
International Rheology. By Dr. G. W. Scott-Blair	679
Correlation of Non-Measurable Variables. By Dr. John Wishart	680
Fungi for Indian Students. By Dr. S. G. Jones	680
Geology of West Denbighshire and Adjoining Areas. By Dr. F. M. Trotter	681
Geology of the Deep-Sea Floor. By Dr. J. D. H. Wiseman	682
The University of Manchester Universal High-Speed Digital Computing Machine. By Dr. T. Kilburn	684
Forests and Man. By Dr. Kathleen B. Blackburn	687
University of Malaya	688
News and Views	689
Phosphorylation of d-Glucosamine by Brain Extracts. By R. P. Harpur and Prof. J. H. Quastel, F.R.S.	693
Quantitative Estimation of Marine Nannoplankton. By H. A. Cole and E. W. Knight Jones	694
Royal Photographic Society: Annual Exhibition	696
British Water-Colours at the Royal Academy. By Dr. A. T. Hopwood	696
Conference on Foundry Steel Melting	697
Letters to the Editors:	
Mechanism of the Action of Urethane in the Treatment of Malignant Growth.—E. Florijn and G. Smits	699
Inhibitory Effect of Thyroxine Analogues on Oxygen Consumption in Mice.—Prof. N. F. Maclagan, M. M. Sheahan and J. H. Wilkinson	699
Competitive Inhibition by Histamine and Thiamine of the Metabolic Influence of Antihistamines on Bacteria.—J. Sterzl and J. Krecek	700
Influence of Histamine on Nerve Block due to Anti-Histaminics.—Dr. Ernst Bárány and Percy Nordqvist	701
Presence of a Spasmogenic Substance, presumably Histamine, in Extracts of Mummy Tissue.—Wilhelm Graf	701
Adenosine Triphosphatase Activity: Spontaneous Dissociation and Recombination of Actomyosin in Extracts from Cross-Striated and Uterine Muscle.—Dr. A. Csapó	702
Study of the Pituitary Body with the Periodic Acid–Schiff Reaction.—Dr. Marc Herlant	703
Sympathomimetic Substance in Human Lumbar Sympathetic Chain.—Jas. D. P. Graham	704
A General Method of Esterification using Trifluoracetic Anhydride.—Prof. M. Stacey, Dr. E. J. Bourne, J. C. Tatlow and J. M. Tedder	705
Metal Catalysis of Indole Production.—E. A. Dawes and Prof. F. C. Happold	705
Synthesis of β-Isomaltose Octa-acetate.—Bengt Lindberg	706
Estimation of Epoxides.—Dr. G. King	706
Synthesis of Geometrical Isomers of Pellitorine and Herculin.—R. A. Raphael and Dr. F. Sondheimer	707
Cross-Linking Reduced Animal Fibres.—W. J. P. Neish and Prof. J. B. Speakman	708
Combustion of Droplets in a Fuel Spray.—G. A. E. Godsave	708
Action of X-Rays on Nucleic Acids.—George Scholes, Gabriel Stein and Dr. Joseph Weiss	709
Preparation of Titanium Esters.—N. M. Cullinane and S. J. Chard	710
Tropospheric Effects in Short and Medium Radio Wave Propagation.—Dr. W. J. G. Beynon	711
Velocity of Electromagnetic Waves.—Comdr. Carl I. Aslakson	711
X-Ray Line-Breadths of Martensite.—Dr. M. A. Jaswon; Dr. Józef Mazur	712
New Method of Excitation of the Cometary Emission Bands at 4050 A.—A. Monfils and Dr. B. Rosen	713
Quantum Mechanics of Canonical Field Variables.—R. Cade	713
Mass of a Lorentz Electron.—Prof. S. J. Barnett	714
Hall Effect in Oxide Cathode Coatings.—D. A. Wright	714
Extraction of Latex of *Hevea brasiliensis* under Sterile Conditions.—Dr. A. I. McMullen	715
Suppression of Axillary Buds in the Tobacco Plant.—Dr. N. L. Pal and Dr. B. S. Kadam	716
Concretions in the Pyloric Gland of *Ciona intestinalis*.—R. H. Millar	717
Formation of Melanin in Regenerating Limbs of a Crustacean.—A. E. Needham	717
Rapid Calculation of Standard Deviations.—G. S. Smith	718

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SCIENTIFIC AND TECHNICAL BOOKS IN GREAT BRITAIN

THE adjournment debate on September 27 in the House of Commons on the licensing of the import of books brought no hope of early relief; but it is at least satisfactory to find that protests are still being made against the handicap which the licensing system places on scientific and technical work. It has since been announced in the Press that the Economic Co-operation Administration has approved the purchase of American technological books and publications costing 22,500 dollars for use by the Department of Scientific and Industrial Research and by affiliated industrial research associations. It may be true, as the Secretary for Overseas Trade stated in the debate, that the balance of payments situation prevents the abolition of the licensing system at the moment; but his reference to the present allowance of 200 per cent by value of the pre-war imports of learned scientific and technical books took no account of the fact that prices had already approximately doubled even before the devaluation of the pound further increased them. Still less did it have regard to the fact that an allowance roughly pre-war in quantity has to serve the needs of workers on whose activities in research and development and at the universities the Government is now spending at the rate of more than £100,000,000 a year instead of £4,000,000, quite apart from the expansion in private industry.

There has now been published by the Library Association the report of a survey, made by Dr. Marjorie Plant under the auspices of the Rockefeller Foundation, into the supply of foreign books and periodicals to the libraries of the United Kingdom*. This admirable report provides the material for a more searching discussion of the real effect of the licensing system so far as users of books are concerned. The report is based on replies to questionnaires sent to librarians and booksellers in the United Kingdom, to publishers abroad, and to the librarians of national and university libraries and of learned institutions throughout the world. The questionnaire addressed to librarians in Great Britain, besides asking for general information as to the annual book grant, additions in 1947, and the normal method of acquisition, asked for details by country of the library's intake of foreign books and pamphlets in 1947, and of the periodicals currently taken in 1948, with certain comparative figures for 1938.

Of the 221 librarians who completed most of the questionnaire, only 130 were able to give statistics, by country, of their foreign accessions during 1947, and Dr. Plant comments that most librarians are unable to say with any exactness how much and what kind of material they have been acquiring from a particular country. The Board of Trade returns indicate that, by weight, there was a general decline in imports of books and periodicals from 322,805 cwt. in 1938 to 223,889 cwt. in 1947, with a more striking

* The Supply of Foreign Books and Periodicals to the Libraries of the United Kingdom. Report of a Survey made under the auspices of the Rockefeller Foundation by Dr. Marjorie Plant. Pp. iii+60. (London: Library Association, 1949.) 2s. 6d.; to Members, 2s.

decline in imports from the United States from 226,923 to 97,066; Canadian imports rose from 5,495 cwt. to 32,044 cwt., those from other British countries from 3,626 cwt. to 4,137 cwt. and those from other foreign countries from 5,046 cwt. to 56,420 cwt. Statistics from nine university and college libraries, fifteen scientific and technical libraries and six public and county libraries show that instead of American acquisitions falling by 43 per cent, they have more than doubled, and foreign acquisitions as a whole were well above the level of 1938. The drastic reduction in United States imports since 1938 accordingly appears to apply mainly to the more ephemeral material. Dr. Plant concludes that if the demand was unchanged, the supply of foreign books was unsatisfactory even in 1938 and allowing for the probability that the 1947 figures were swollen by the acquisition of war-time arrears. Nevertheless, the supply in the United Kingdom probably compared favourably with the foreign acquisitions of libraries in other countries.

Detailed returns received from a group of sixteen university and college general libraries showing a total expenditure in 1947 on books and periodicals of £35,756 indicated that roughly 25 per cent of the 40,741 non-serial publications required came from abroad, books and pamphlets coming from the United States and France being about equal in number (3,084 and 3,082, respectively), with Germany (1,338) and Switzerland (420) next. Of the serial publications, 1,390 periodicals and 78 Government serials came from the United States, 467 periodicals from France and 156 from Germany; but none of these libraries received a single Government report or serial from France, Germany, the Netherlands or Denmark.

The expenditure of a group of fourteen medical libraries was £5,497; and of the 3,720 non-serial publications received, a little more than 30 per cent were from abroad. Of the books and pamphlets, 591 came from the United States, France being next with 66. Of the periodicals, 482 and 34 Government serials came from the United States and 104 periodicals from France; but in all, acquisitions came from more than seventy other countries. The total expenditure of twenty-five out of a group of twenty-seven representative libraries in science and technology on books, pamphlets and periodicals including Government publications in 1947 was £18,967, and of the 14,032 non-serial works acquired by all these libraries, roughly 48 per cent were from abroad. The United States again was the chief supplier, with 3,813 books and pamphlets, 719 non-serial Government reports, 1,350 periodicals and 228 Government serials. France came next with 596 books and pamphlets and 249 periodicals, followed by Germany (307 and 80, respectively), Sweden (196 and 68) and the Netherlands (164 and 102). The proportion of Government publications in this group is appreciably larger.

In a group of twelve libraries concerned with the social sciences, the total expenditure on acquisitions was £7,048, and of the 15,685 non-serial publications acquired, approximately 45 per cent were from abroad. More than half the total and the foreign items were for the British Library of Political and Economic Science. The United States was again the chief source of supply with 1,874 books and pamphlets, 331 non-serial Government reports, 703 periodicals and 998 Government serials; but the discrepancy was less marked, 888 books and pamphlets, 67 periodicals and 74 Government serials coming from Germany, and France supplying 604 books and pamphlets, 53 non-serial and 74 serial Government publications and 67 periodicals. Besides these figures, the British Museum subscribes for 2,897 periodicals from abroad, of which 2,244 are Government publications, and receives many others by gift. Its purchases of foreign books and pamphlets declined from 8,095 to 5,794. The Bodleian Library with its dependent libraries receives altogether about four thousand periodicals from abroad.

Putting all these returns together by countries, the great preponderance of the United States is again very evident, as is the very small number of publications coming from South America. Dr. Plant, however, raises the pertinent question whether, in those libraries which are acquiring as much material from abroad as from the United Kingdom, it can really be assumed that the other 50 per cent covers all the correspondingly important publications of the United States, France, Germany, Italy, Spain and the rest of the world. Of the university and college librarians consulted, leaving out the Oxford and Cambridge colleges, which have the Bodleian and Cambridge University Libraries as reserve, there are nine which are satisfied with their acquisitions and eighteen which are not; but in special libraries of all types thirty-nine librarians stated they were obtaining all the publications they required, and sixty-three wanted more.

On the other hand, only fifty-one librarians complained of shortage of funds for buying foreign books, a figure surprisingly small in view of the expenditure quoted by Dr. Plant and in the recent "Returns from Universities and University Colleges in receipt of Treasury Grants", in which the University Grants Committee has included a table on library expenditure. A greater difficulty appears to be in knowing what to order, and this was the complaint of eighty-nine librarians. In the absence of more definite information about new foreign publications, the librarian cannot always be sure that he is spending his money to the best advantage. In this connexion the licensing regulations appear to be a minor inconvenience. Dr. Plant includes a number of suggestions for improving the position as well as some useful regional notes on the state of the book trade in various countries and a list of addresses of foreign publishing houses. Names of libraries prepared to send, on request, lists of their recent acquisitions of English books to librarians abroad or to other librarians in the United Kingdom and lists of their recently acquired foreign books, are also appended to a report into which, for its size, a surprising amount of information has been packed.

The report was completed before the devaluation of the pound, but the figures given show how greatly that will affect the budgets of libraries wishing to

maintain their present acquisitions of American publications; and especially in the scientific and technical group already drawing from foreign services nearly half their acquisitions, and of this half some 70 per cent from the United States. Two comments might be made on that aspect in conclusion. On the evidence given in this report, the Government could well afford, even in the present dollar position, to drop the licensing system so far as *bona fide* scientific and technical libraries are concerned. Further, no discussion on the importation of foreign books is complete that does not probe the reasons for this excessive dependence on American scientific and technical books. It is certainly not due to inherent deficiencies in British scientific men and technologists. Indeed, it might be suggested that at the present time it should be a major preoccupation of scientific workers and technologists in Britain to attempt to make good some of the gaps in the output of British books which have been caused during the past ten years by their pre-occupation with the prior claims of war-work and recovery. Some of the senior workers now going into well-earned retirement but yet full of vigour and of ripe experience might take an active part, both directly and indirectly, in this task of stimulating, and also contributing to, a healthy flow of British scientific and technical books.

INTERNATIONAL RHEOLOGY

Proceedings of the International Congress on Rheology, Holland, 1943

Edited by the Organising Committee. Pp. 15 + 640. (Amsterdam: North-Holland Publishing Co.; New York: Interscience Publishers, Inc., 1949.) £3 3*s*.

WHEN the Society of Rheology held its first conference in Washington in December 1929, it was the intention of at least some of its leading members, certainly including the late Prof. E. C. Bingham, that the Society should eventually be international and that branches should be set up in other countries, including Britain. For various reasons this intention was not fulfilled, but, although only a small number of foreign delegates attended the Washington conference, nevertheless it had something of the atmosphere of an international gathering.

When the British Rheologists' Club held its first conference at Oxford in 1944 it was quite clear, of course, that it was a national body, and the Conference on Viscosity of Liquids and Colloidal Solutions, held in Moscow just before the German invasion in 1941, though representative of many sections of the vast territories of the U.S.S.R., made no claim to be international.

Accounts of how the First International Congress on Rheology came to be held in Scheveningen in September last and of its relation to the Joint Committee on Rheology (I.C.S.U.) have already appeared in *Nature* (**161**, 104; **162**, 747; 1948). Now that the Proceedings of the Congress have been published, it is interesting to compare their contents with those of the earlier Conferences. (See *J. Rheol.*, 1, Nos. 2, 3, 1930; "Essays in Rheology", Pitman, London, 1946; *Nature*, **156**, 147, 1945; **157**, 455, 1946.)

During the past twenty years rheology has developed many new branches; but its roots have not extended correspondingly in depth. Application to a host of industries, extended use in medicine and in the arts and an ever-widening vocabulary there have certainly been; but in fundamental theory the foundations are but little changed. Notable exceptions are concerned with the kinetic theory of elasticity and viscosity in liquids. H. S. Green's lecture on this subject is far in advance of anything that could have been read in Washington in 1929. The theory of rate processes, which American rheologists have applied widely since Glasstone, Laidler and Eyring's book was published under that title in 1941, also marks a considerable advance, but was scarcely mentioned at Scheveningen, perhaps because the rather late date of the Congress made it difficult for more than a very small number of American rheologists to attend. Work on anelasticity, a field to which there has been considerable fundamental advance, especially in relation to metals, also had scarcely any place in the Proceedings.

In spite of determined efforts on the part of those organising the Congress, no Russian rheologist was present and the Proceedings lack all account of the theoretical work of Frenkel and his school, and also of the very wide practical applications of rheology which have been made by Volarovich.

Although it is therefore apparent that one cannot regard the Proceedings of the First International Congress as fully representative of the present state of the science, the lectures and papers do form a very interesting collection of reports of work in progress in various parts of the world.

Fundamental theory still rests on the twin foundations of the theories of elasticity and of viscosity. K. Weissenberg's transformation theory seeks to find invariant quantities and relations under conditions such that the simplifying assumptions of classical theory are inapplicable, and M. Reiner has studied various combinations of elastic and viscous units which can be made to account for much complex rheological behaviour.

Applications of rheology to older industries are discussed by many authors, but it is perhaps natural that a greater emphasis rests on the study of synthetic macromolecules. The viscosity-concentration relations of dilute solutions of such systems are fast elucidating the intricacies of molecular structures; but this work has not hitherto been very well co-ordinated, and C. Sadron's lecture does much to present the picture as a whole. R. Houwink, with his wide knowledge of industries old and new, gives interesting comparisons between the thermally and chemically controlled consistency of plastics and the humidity controlled 'body' of clays. A. L. Copley's able summary of biological applications shows how much waits to be done in this field, rather than stressing present achievements; and it is interesting that only one sectional biological paper, that of W. T. Astbury, on the interaction of myosin and actin, was read. Though Sullivan and her colleagues published psychological studies on the direct perception of rheological states in the early 'twenties, only one laboratory appears to have followed up this work under rheologically controlled conditions, and psycho-rheology, like bio-rheology, was represented at the Congress by one lecture only (G. W. Scott-Blair) and by a single sectional paper (R. Harper).

Experimental procedures have developed considerably in recent years, and F. R. Eirich's critical summary should help many rheologists in the difficult choice of methods.

The discovery of new phenomena and the development of original concepts have presented problems of classification and nomenclature which did not exist twenty years ago. During the War isolated national groups, especially in Britain and the Netherlands, attempted to formulate principles of classification. At Scheveningen, J. M. Burgers presented a tentative report which he and G. W. Scott-Blair had been asked by the International Joint Committee to prepare. Following criticism and discussion, a second edition was completed in March 1949 and is included as an appendix to the Proceedings.

Agreement on such matters cannot be forced and can only come by a slow process of assimilation and development. The report covers only a limited part of the field of rheology, but it is hoped that it may serve as a basis for future discussion and extension.

With regard to the production of the book, the publishers and the organising committee are to be congratulated on having the Proceedings, including all the discussions, published within ten months of the Congress; and in gratitude for this one can afford to ignore the excessive weight associated with the mimeograph type (offset printing) and the not very effective binding. It might, perhaps, have been better to have rearranged the papers by subjects, rather than to have kept the original lectures and sectional papers separate. For example, K. Weissenberg's general lecture, his paper (with S. M. Freeman) in the Theoretical Section, and his description of the rheogoniometer in the Experimental Section, though rightly separated at the Congress, would read better as a whole; and the pairs of biological and psychophysical papers could also profitably have followed one another in the published Proceedings.

In spite of the high price this is a book which should be on the shelves of every rheologist. It is sincerely hoped that it will prove to be the first of a series, and that world conditions will permit later Congresses to represent even more completely the progress of rheology throughout the world.

G. W. Scott-Blair

CORRELATION OF NON-MEASURABLE VARIABLES

Rank Correlation Methods

By Maurice G. Kendall. Pp. vii + 160. (London: Charles Griffin and Co., Ltd., 1948.) 18*s*. net.

It was in experimental psychology that the methods of rank correlation were first introduced, and Spearman's coefficient ρ has been familiar to statisticians for many years. More recent work on the same lines has produced an alternative coefficient τ (by Kendall) and a general coefficient (by Daniels) of which the above two, and even the familiar product moment coefficient, are particular cases. It is still, for the most part, psychological workers who are interested in this branch of statistics, since many of their observational variables are non-measurable. This has stimulated research in what has proved to be a somewhat difficult mathematical field; and in the book under review Prof. M. G. Kendall has gathered together what is known on the subject, and has given a coherent mathematical treatment to it all. With the growth of mathematical statistics, it seems inevitable that books should begin to be issued on specific topics within the general framework, and this book is to be welcomed as a worthy addition to such a series.

Beginning with a study of the measurement of rank correlation, the author then introduces a general theory of rank correlation in the straightforward cases and adds a chapter on tied ranks to deal with a difficulty previously disregarded. In the next section the necessary tests of significance are developed. The further topics taken are (*a*) the problem of m rankings, (*b*) partial rank correlation, (*c*) relationship of rank and normal correlations, and (*d*) paired comparisons. The somewhat novel course is followed of 'interleaving' the above topics from 'tests of significance' onward (with the exception of 'partial rank correlation') with separate chapters giving proofs of the results. The idea is not to disturb the continuity of the treatment in the case of those interested only in the applications of the theory by expecting them to study the mathematical details; at the same time, for the benefit of the more mathematically inclined, the full proofs are presented. In the past, text-books on method have either left out the proofs or relegated these to appendixes. The present format is equivalent to putting a series of appendixes at the end of the different chapters, except that they are here numbered as separate chapters. It is really a distinction without a difference, and no one can seriously quarrel with the method. The fate that often attends mathematical proofs relegated to appendixes is that they are not read.

A commendable attempt has been made to formalize the theory, and so put it on a par with other coefficients of statistical theory. It is very unlikely that the last word has yet been said, and undoubtedly there are still difficulties to face. The subject is a live one, however; and for those who wish to go on with it, or to use the best-known methods, the present book will be exceedingly valuable as avoiding on one hand the painstaking business of reading up from scattered publications all that has previously been written on the subject, and on the other as presenting clearly the methods to be followed, with a wealth of illustrative material.

The book concludes with an appendix of some ten sets of mathematical tables (some of them reproduced standard statistical tables) in order to present within the covers of the volume all the tabulated material needed to aid the computations.

John Wishart

FUNGI FOR INDIAN STUDENTS

Fungi and Plant Disease

By Dr. B. B. Mundkur. Pp. x+246. (London: Macmillan and Co., Ltd., 1949.) 16*s*. net.

It is gratifying to find yet another teaching mycologist turning to the work of the late Sir Edwin J. Butler for help and inspiration. In this book, Dr. B. B. Mundkur has undertaken to write on "Fungi and Plant Disease" for students pursuing agricultural or cognate courses in various colleges in India. The author, in his preface, pays high tribute to the pioneer of mycological teaching in India, when he acknowledges his indebtedness to Sir Edwin Butler and to his book, "Fungi and Disease in Plants", published in Calcutta more than thirty years ago. The author of this new work is to be highly congratulated for getting so much information about fungi into a book of comparatively smaller compass.

The first five chapters deal with general principles relating to morphology, reproduction, metabolism, disease symptoms, including a very useful but brief chapter on methods of studying plant diseases, with an excellent introduction to the classification and naming of fungi. Adopting a different plan from that of Sir Edwin Butler, the author follows a systematic arrangement of a number of parasitic fungi which attack the more important and representative economic plants occurring in India. Preceded by an introductory account to each of the groups, twelve types are described in the Phycomycetes (succeeded by a concise account of the Zygomycetes), eight in the Ascomycetes, thirteen in the Basidiomycetes, and nine in the Fungi Imperfecti. The treatment given to the smut and rust diseases is especially praiseworthy, the former including a useful key to the identification of some of the more important smut parasites of crops in India. The last three chapters, which strictly do not come within the title of the book, deal briefly with bacterial diseases, virus diseases and plant-disease control. The bibliographies at the end of the chapters are mainly of references to general treatises.

The text is very free from errors, but a few ambiguous statements occur, such as submerged mycelium being described as endophytic; that ectoparasites alone are furnished with "holdfasts called appressoria"; "stroma" appears in place of "stromata"; and it is scarcely correct to refer to the cushion-type of sporophores as "sporodochia *or* acervuli". In an excellent account of sexuality in the fungi, where fertilization is described as isogamous or heterogamous, the statement occurs that "the male gamete is known as an antherozoid" (a term rarely used in the fungi), and yet zygospores are described on the same page as the result of isogamous copulation.

A pleasing feature throughout the book is the use of clarendon type for salient technical terms, though it is rather disconcerting to read the name of the host bracketed with that of the disease, for example, "Late Blight of Potatoes (*Solanum tuberosum* L.)" in place of the name of the causal parasite. The book is richly illustrated with line and half-tone figures, and the whole production is in excellent style.

S. G. JONES

GEOLOGY OF WEST DENBIGHSHIRE AND ADJOINING AREAS

The Middle Silurian Rocks of North Wales

By Prof. P. G. H. Boswell. Pp. xvii+448+25 plates. (London: Edward Arnold and Co., 1949.) 80*s*. net.

WE appear to have entered into the planning age, and since one of the important foundations of planning is knowledge of the earth—its surface, soils, rocks and minerals—it is desirable that planners should have some knowledge of the science of geology. This is particularly so in the case of regional and district planners, for in addition to geological principles they should be familiar with the geology of the ground which falls within their domain. Engineers, geographers and town and country planners in North Wales can account themselves as fortunate in having placed at their disposal Prof. Boswell's new book.

The book is in two parts. The first part, in giving a general description of the Mid-Silurian rocks of North Wales, also deals with the principles which have governed their formation from deposition as sediments to their present disposition and their influence on scenery and topography. The account is profusely illustrated by numerous plans, maps, diagrams and photographs.

In the second part of the book the rocks of West Denbighshire and adjoining areas in Carnarvonshire and Merionethshire are systematically described in fourteen chapters each devoted to a district within the area. This part of the book gives such detailed information that it can be best described as a well-documented and amply illustrated reference book.

The book, however, is not written solely or even specially for engineers and planners. It presents the results of the geological work in North Wales during the last quarter-century of Prof. Boswell and his band of enthusiastic co-workers from the University of Liverpool, and it contains much information which has not been published previously. It will take its place on the bookshelves of geologists with other important district geological memoirs.

To the geologist two important features are first, the elucidation of the stratigraphical sequence, and secondly, the interpretation of the structure of the district. The former is based essentially on the recognition of the graptolite zones of the Wenlock and the Ludlow from the zone of *Cyrtograptus murchisoni* to *Monograptus leintwardinensis* inclusive, in an extended sequence of grits, flags, siltstones and mudstones.

In a broad survey there is a cautious approach to the interpretation of the structure of the area best illustrated by comment on two aspects of the problem, namely, faulting and intraformational disturbances. The trends of no less than 850 faults have been measured and these group themselves into two dominant directions, the *n*-faults of north to north-westerly trend and the *e*-faults with a general easterly trend. Prof. Boswell does not favour the theory of principal stresses as an explanation of the fault pattern. He considers that some of the faults may be of Caledonian Age but is inclined to the opinion that most of them are of Armorican Age (with some posthumous movement along the older faults) and may be due to rotational stresses. The influence of post-Triassic movements is indicated by the rift-valley of the Vale of Clwyd. In short, there is no single and simple explanation of the fault pattern; the fault system as seen to-day represents the cumulative activity of three major earth-movements. There is the same cautious, almost judicial, approach to the problem of interpreting intraformational disturbances. Here again, no single or simple explanation is considered to fit all of the observed and described phenomena. Some disturbances are accounted for by submarine sliding; the sliding, however, was local, covered no great area and involved beds up to thicknesses of the order of 10 ft. Other disturbances were probably formed under relatively light load when the sediments were partially consolidated. Others, wholly tectonic in origin, were formed during the Caledonian orogeny. Not infrequently the disturbances are considered to be due to a combination of these causes.

How often in geology do we find truth in a compromise embracing the essentials of what formerly appeared to be conflicting theories.

F. M. TROTTER

GEOLOGY OF THE DEEP-SEA FLOOR

AT the recent meeting of the British Association at Newcastle upon Tyne, six papers were given before the Geological Section on problems concerning the deep-sea floor. There was, in addition, an evening lecture by Prof. Hans Pettersson[1], the leader of the Swedish Deep-Sea Expedition, 1947–48, in which he described the results so far obtained from investigations on the material brought back by the expedition. Judging by the enthusiasm at both the sectional meeting and the evening lecture, the study of the deep-sea floor is of general interest. This is doubtless due to the fact that the deep-sea floor, covering approximately two-thirds of the earth's surface, is an almost unexplored region, and the solution of its problems, requiring the application of many sciences, will have an important influence on other earth sciences.

Chronology of Deep-sea Deposits and Climatic Oscillations

For the interpretation of the changing phases in oceanic evolution, as revealed by sedimentary and biological investigations on long cores, it is necessary that there should be methods of establishing the age, or at least of correlating significant horizons. Prof. Pettersson's paper on "The Chronology of the Ocean Floor" dealt with the methods used for correlation in deep-sea cores; first the radioactive method, second the mineralogical method, third the pollen analysis method, and fourth the biological method. As the duration of the Pleistocene was approximately one million years, it is impossible to measure time by the slow disintegration of uranium into stable end-products. In deep-sea deposits the content of uranium is surprisingly low (about $1 \cdot 8 \times 10^{-6}$ gm. per gm.) as compared with the theoretical value in equilibrium with the relatively high radium content found in the topmost layers of deep-sea cores. This high content of radium was explained by Prof. Pettersson as being a result of the precipitation from sea-water of the element ionium, along with ferric hydroxide. Such a hypothesis would explain the low radium content of sea-water (about 1×10^{-13} gm. per litre) as compared with its theoretical equilibrium value with the dissolved uranium of about 5×10^{-13} gm. per litre. Prof. Pettersson explained the possibility of determining the average rate of sedimentation on the deep-sea floor during the past ten thousand years on the assumptions that (*a*) eighty per cent of the ionium produced from the uranium in sea-water is precipitated and that this proportion has remained constant; (*b*) that the rate of accumulation of ionium has remained constant; and (*c*) that no radium of different origin has entered into the deposit. The rate of sedimentation arrived at by this method is, according to Prof. Pettersson's calculations, in agreement with the generally accepted value for red clay.

An alternative method of determining age during the latter half of the Pleistocene is by determining the changing concentration of radium with depth in the core. Dr. W. D. Urry[2] has shown that, if it is assumed that a constant concentration of elements of the uranium-238 series has been deposited with time, it is possible to give quantitative equations governing the growth and decay of these elements, and, in consequence, an age to any particular horizon in a core can be assigned from a knowledge of the radium distributed. This promising method is now being applied to cores taken during the cruise of the *Albatross*; but it is only suitable for the latter half of the Pleistocene.

Concerning the mineralogical methods of establishing correlations, Prof. Pettersson pointed out both the use of ash bands in establishing isochronic surfaces and of detailed mineralogical analysis. He particularly referred to the work of Dr. M. N. Framlette and Dr. W. H. Bradley[3] on the North Atlantic cores, and gave a tentative correlation of the uppermost volcanic layers found in long cores from the Tyrrhenian Sea with the historical eruptions of Mt. Vesuvius. There are unfortunately limitations to correlations by the mineralogical method owing to differentiation both in the atmosphere and the sea, and the method can only be used for relative chronology of volcanic outbursts earlier than historical times. Dealing with the pollen analysis method, Prof. Pettersson considered that there are possible applications on a limited scale in the case of cores collected near islands or continental coasts. It was his opinion that the biological method, depending on the statistical distribution of planktonic organisms sensitive to temperature changes, is the most promising.

The importance of planktonic foraminifera as temperature indicators was demonstrated in a paper by Mr. C. D. Ovey, of the British Museum (Natural History). From a study of nine deep-sea floor samples from different latitudes, Mr. Ovey gave a clear proof that specific species of foraminifera are sensitive to temperature variations. The changes in the proportions of 'cold', 'temperate' and 'warm' species, determined by counting about a thousand specimens (those smaller than 125 μ in diameter were ignored), were followed from the Southern Ocean to the Arctic, and the general correlation between the percentages of these groups and the surface sea temperature was pointed out. For example, Mr. Ovey found that a sample from lat. 66° 38′ S., long. 178° 47′ W., where the sea temperature is nearly 0° C., consisted of 98·8 per cent cold species (predominance of *Globigerina dutertri* and *G. pachyderma*), whereas near to the equator (lat. 0° 1′ S., long. 15° 16′ W.), where the surface temperature was 24° C., the warm species (mainly *Globigerinoides sacculifera*, *G. rubra*, *Globorotalia menardii*) composed 97·1 per cent of the sample. At an intermediate locality (lat. 32° 32′ S., long. 1° 23′ W.), where the surface temperature was 17·5° C., temperate forms (mainly *Globigerina inflata*, *G. bulloides*, *Globorotalia truncatulinoides*) made up 89·7 per cent of the sample. It is evident from Mr. Ovey's paper, as well as from similar work carried out by Dr. Phleger[4], of Woods Hole Oceanographic Institute, that when there is more information about the geographical distribution of individual living species, as well as the temperature limits within which breeding can proceed, it may be possible from a knowledge of the percentage distribution of cold, temperate and warm species at any horizon in a core to assign approximate temperature limits to the surface of the ocean. In conclusion, Mr. Ovey indicated that past climatic oscillations can be determined from statistical investigations on fora-

minifera isolated from different horizons in a core. Work on these lines will shortly be undertaken on a core 15·4 m. in length, kindly supplied by Prof. Pettersson.

Nature of Deep-sea Basins

The origin and date of formation of deep-sea basins is of special significance to those interested in the distribution of fauna and flora. Three important papers were given which have a considerable bearing on this subject. The first, by Prof. Ph. H. Kuenen, of Holland, dealt with the formation of the continental shelf. This feature has been attributed to marine erosion, to deposition on the continental slope, and to deposition on subsiding foundation with or without warping or faulting. In the opinion of Prof. Kuenen, the continental shelf off Cape Hatteras (lat. 35° 14′ N., long. 75° 32′ W.) originated through the formation of a sedimentary prism to the east of the late Jurassic coastline, which was situated slightly to the east of Cape Hatteras. The weight of the sediment would cause isostatic subsidence, and in consequence a broad strip some 50–150 km. subsided. Prof. Kuenen explained that the shelf would grow both towards the continent (that is, westward) by top-set beds and towards the open ocean (eastward) by fore-set beds. Eventually, however, elevation would proceed eastward from the continent, as there would be a tendency for the coastal region to regain local isostatic equilibrium. In consequence of this the coastal region, which was originally bent down through the weight of sediment, would rise. In support of this theory Prof. Kuenen mentioned (*a*) that the information obtained from oil wells drilled in the Cape Hatteras coastal area[5] indicates a prism of Upper Cretaceous and Tertiary strata resting on a weathered granite surface; and (*b*) that the gravity investigations of Prof. Vening Meinesz[6] prove that on the continental shelf there is no appreciable divergence from isostatic equilibrium, which, in Prof. Kuenen's opinion, indicates that three-quarters of sedimentary volume on the continental shelf is due to isostatic subsidence.

The floor of the Indian Ocean with special reference to the Arabian Sea was described by Lieut.-Colonel R. B. Seymour Sewell, who was the leader of the *John Murray* Expedition of 1933–34. The Arabian Sea is divided into two basins by the Arabian or Carlsberg Ridge, which runs in an arc from Socotra to near the Chagos Archipelago. To the south-west lies a second ridge—the Seychelles or Mascarene Ridge—bearing the Seychelles group of islands at its northern end and Mauritius at its southern extremity. Continuing south from the Arabian Ridge is the Mid-Indian Ridge, which is crowned by the islands of New Amsterdam and St. Paul, and this merges into the Kergaelen-Gaussberg Ridge. It is not yet known whether this ridge is continuous throughout its whole length. Colonel Seymour Sewell discussed the date of formation and nature of these ridges, and expressed the view that they are of early Tertiary age. In the case of Providence Reef[7] there is definite evidence that its foundations are early Tertiary in age. The coastal regions of the Arabian Sea are characterized by a series of scarp faults, and in some areas there are indications, for example, along the Makran and Baluchistan coasts, that the faulting was late Tertiary. Colonel Seymour Sewell recalled that basalts[8] have been dredged from the Arabian Ridge as well as in the basin to the north-east, and that these are both chemically, as well as in their radium content, quite distinct from the Deccan Trap. He further referred to the work of Dr. H. G. Stubbings[9], who from a foraminiferal analysis of short cores from the Arabian Sea obtained evidence for four cold phases.

Some of the geophysical methods for the exploration of the deep-sea floor were described by Mr. B. C. Browne, of the Department of Geodesy and Geophysics, Cambridge. The 1938 and 1946 gravity surveys to the west of the British Isles, carried out in the submarine H.M.S. *Tallent*, were described. On the continental shelf the isostatic anomaly is on the average + 7 milligals with a scatter of ± 10 mgl., while to the west of the continental shelf the average isostatic anomaly is + 11 mgl. with a scatter of ± 19 mgl. The high scatter over the deep-sea, as compared with that over the continental shelf, can be explained on the assumption that blocks of granite are set in a matrix of basalt, or alternatively if there are large pools of sediment. As Mr. M. N. Hill, of the Department of Geodesy and Geophysics, Cambridge, has recently found by seismic refraction methods a very considerable thickness of sediments in the East Atlantic Basin, it would seem more likely that the latter hypothesis is correct.

Surface of Deep-sea Floor

A paper was read by Dr. J. D. H. Wiseman, of the British Museum (Natural History), on manganese nodules found on the surface of the deep-sea floor of the Arabian Basin. Manganese nodules which occur abundantly in oxidizing environments have aroused interest for more than three-quarters of a century, but their origin is still obscure. In the Arabian Basin they are associated with red clay and are largely composed of manganese, iron and water. They contain, in addition, unusual amounts of nickel, copper, cobalt, barium and radium. The shapes of the nodules are generally spherical, hemispherical, tetrahedral or potato-shaped, and from an examination of the internal structure Dr. Wiseman concluded that the tetrahedral nodules originated through the fragmentation of spherical nodules. Definite confirmation about the fragmentation of spherical nodules and the deposition at a later date of a secondary manganese layer is given by the distribution of radium in tetrahedral nodules. According to determinations kindly made by Dr. J. H. J. Poole, of Trinity College, Dublin, the radium content of the secondary peripheral layer is practically constant (11×10^{-12} gm. per gm.), while immediately below this layer the content is much lower ($0{\cdot}9 \times 10^{-12}$ gm. per gm.), and towards the centre no radium could be detected. It is clear from these determinations that the original nodule was spherical with increasing radium content towards the periphery, and that it afterwards broke into tetrahedral masses, around which a secondary layer of manganese material was deposited. In the Arabian Basin nodules a delicate microcellular structure has been detected. The cells are of an average diameter of 0·1 mm. and are arranged in a radial direction. They are capped by concentric layers of a dark-brown isotropic substance.

Future of Oceanic Exploration

It is clear from the papers referred to above that, with the rapid development of new techniques for the exploration of the deep-sea floor, our knowledge of oceanic evolution will rapidly be removed from the realm of geological speculation. It may, for example, be possible, when more investigations have been

made, to determine the origin and date of formation of the deep-sea basins, as well as that of the major tectonic features. The considerable thickness of sediment overlying the rock substratum in the East Atlantic Basin suggests, on the assumption that the rate of sedimentation approximates to the rate in the latter half of the Pleistocene, that at least part of this basin is of considerable age. It is now possible, according to a personal communication from Prof. W. Weibull, to distinguish seismic reflecting layers which are separated by only 20 m., and the Swedish Deep-Sea Expedition found in the East Atlantic Basin three reflecting surfaces at 1,540 m., 2,220 m. and 3,460 m. This great thickness of sediment is in general agreement with that found by recent seismic refraction surveys carried out by the Department of Geodesy and Geophysics at Cambridge, and such sedimentary pools would, as previously noted, account for the large scatter of the isostatic gravity anomalies over the ocean, as compared with the much smaller scatter over the continental shelf.

Important events during the Pleistocene or even earlier are revealed by sedimentary investigations on the long cores which can now be obtained using the Kullenberg piston core sampler; and by means of statistical studies of planktonic organisms sensitive to temperature changes, it is possible to obtain a record of climatological changes during the Pleistocene, and to test the various theories concerning the origin and dating of these climatic changes. It would, for example, be significant to know whether these changes synchronize or alternate in the southern and northern hemispheres.

The International Commission on Oceanography held its third meeting at Newcastle, and it was strongly urged that as a result of recent developments in deep-sea research international co-operation is desirable, and with this in view the Commission examined the desirability of establishing an international union or bureau. J. D. H. WISEMAN

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[2] Urry, W. D., *Amer. J. Sci.*, **240**, 426 (1942).
[3] Bramlette, M. N., and Bradley, W. H., U.S. Geol. Surv. Prof. Paper 196-A (1942).
[4] Phleger, F. B., *Göteborg. Vetensk. Samh. Handl.*, (vi, Ser. B), **5**, No. 14 (1948).
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[8] Wiseman, J. D. H., John Murray Exped. 1933–34, Sci. Rep., **3**, 1 (1937).
[9] Stubbings, H. G., John Murray Exped. 1933–34, Sci. Rep., **3**, 159 (1939).

THE UNIVERSITY OF MANCHESTER UNIVERSAL HIGH-SPEED DIGITAL COMPUTING MACHINE

By Dr. T. KILBURN

THE electronic computing machine described here has been developed in the Electrical Engineering Laboratories at the University of Manchester under the general direction of Prof. F. C. Williams, and with the active assistance of the Telecommunications Research Establishment, Malvern.

The use of electronics in machines of this type follows from the requirement for high-speed operation. A further consequence of this requirement is the desire to eliminate, so far as possible, the necessarily slow process of human intervention, which is essential at every stage of the solution if conventional methods of computing are used. The minimum extent to which this intervention could be conveniently reduced would be to present to the machine an oral or written statement of the problem, in much the same way as problems are presented to a human computer. Research in electrical engineering and mathematics has produced computing machines at Manchester, Cambridge and in the United States, of a type which approximate to this ideal. However, a simple statement of the problem is insufficient. The problem must be programmed, that is, it must be split up into a series of simple operations which the machine can perform. Each operation is represented by an instruction, and these instructions, and the data which they control, are coded in a form which the machine can interpret. During the actual solution of the problem by the machine, however, the need for human intervention is entirely eliminated, for all the data—instructions and numbers—are loaded into the machine initially. The solution then occurs at a speed determined only by the electronic circuits used. To permit this initial loading, the machine must have a 'memory' or storage facility. One storage system used in the Manchester machine has been fully described elsewhere[1]. It is clear that as the capacity of the storage is increased, the programming of problems becomes easier; for mathematical operations common to many problems may be programmed, and introduced permanently into the storage of the machine. It will then be necessary to construct only 'master programmes', which call upon these 'sub-programmes' appropriately, and a nearer approximation to the ideal is achieved without further engineering being necessary.

The important engineering requirements resulting from the above discussion are as follows: (i) representation and interpretation of data; (ii) storage, and input and output devices; and (iii) computing circuits. These items are now discussed with reference to the machine at Manchester.

Representation and Interpretation of Data

The binary system of numbers[1] is used throughout the machine, because of the simplicity and economy with which it can be represented electrically. In this system of numbers, it is only necessary to represent the digits 0 and 1. Thus, in a machine operated in the 'series' mode, the binary number 10101 (decimal 21) is conveniently represented by a train of negative pulses occurring sequentially on a single wire, as shown in Fig. 1.

Now, if the stored items of data are considered to exist in numbered 'addresses', s, in the main storage of the machine, and if, further, the operations or functions, f, which the machine can perform are numbered, then it follows that an instruction, in its simplest form, consists of two numbers (s, f), and may be represented in the same way as a number. In fact, instructions and numbers differ only in the way in which they are used by the machine. Instruc-

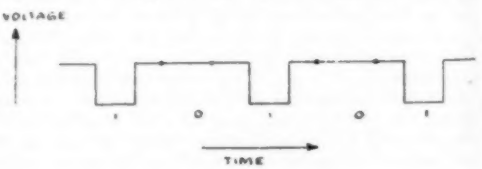


Fig. 1

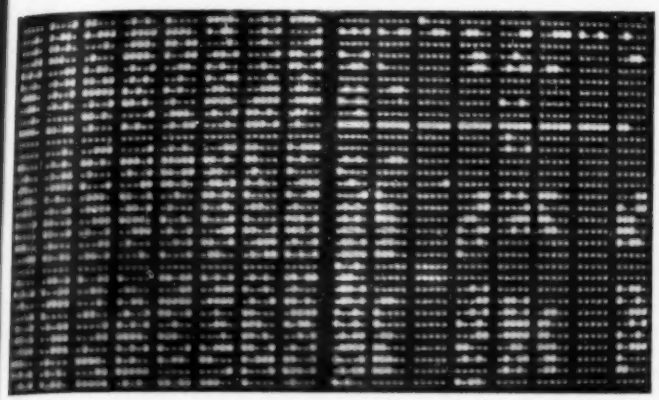


Fig. 2

tions are converted from the 'dynamic' form shown in Fig. 1 into a 'static' form by a set of trigger circuits called a 'staticisor', and are held in this condition for a sufficient time to enable, say, a stored number to be 'read' from a selected address, s, and transferred to a selected computing circuit f.

It will be seen that instructions specify addresses, and not the contents of those addresses. Thus, a programme is universal in the sense that, once devised, it can be used to operate on different sets of data without modification.

Storage

The main storage of the machine, which initially holds all the data relevant to a problem, is now discussed.

An important feature of any storage system is its accessibility ratio,

$$\alpha = t_1/t_2,$$

where t_1 is the time taken to read a chosen address of the store, and t_2 ($> t_1$) is the time elapsing between the demand for that information being made, and the end of the reading process.

Clearly, it is necessary that the part of the storage to which access is frequently made should have a value of α approaching the optimum value of unity, if the time taken in solving a problem is not to be extended by barren periods of waiting. In the electronic storage system[1] used, $\alpha = 1$. However, it is unnecessary to have $\alpha = 1$ for all the storage, and, in fact, a magnetic storage system, for which $\alpha = 1/133$, is used to supplement the electronic system. This is made practicable by transferring blocks (tracks) of information between the magnetic and electronic systems; and by having sufficient electronic storage to ensure that, on the average, access to the magnetic storage is not a sufficiently frequent occurrence to affect appreciably the time of solution. With this proviso, magnetic storage is a useful, if not indispensable, adjunct in view of its compactness, permanence of record, and reliability.

A photograph of the face of an electronic storage cathode ray tube, during the course of the solution of a problem, is shown in Fig. 2. The binary digits 0 and 1 can be seen in the photograph, where they appear as dots, and vertical dashes, respectively. A single storage tube has a capacity of 2,560 digits, arranged in two rasters of television type, where each raster has 32 lines, and each line of a raster holds 40 digits. The lines of the rasters, each of which holds one 40-digit number or two 20-digit instructions, correspond with the storage addresses previously mentioned. It will be seen that the 40 digits of a line are arranged in 8 groups of 5, which is convenient for visual reading of data, and corresponds with teleprinter practice. Input is at present achieved by a keyboard, arranged in the form of a typewriter, by which the state of any digit in the store can be changed from 0 to 1, or *vice versa*. Output is achieved by visual reading from the known answer lines, in teleprinter code, by inspection of a cathode ray tube face. These methods of input and output will very shortly be replaced by teleprinter apparatus. The conversion from decimal to binary, and from binary to decimal numbering, at the input and output, respectively, will be achieved by the machine itself.

The magnetic system of storage[2] uses a 12-in. diameter nickel-plated drum, rotating in synchronism with the scanning of the electronic storage tubes. Each recording track on the drum holds the same number of digits as a cathode ray tube, and the synchronized method of operation ensures one-to-one correspondence between digit position on track and tube.

The present machine has an electronic storage capacity of 5,120 digits, and a magnetic storage capacity of 40,960 digits.

Computing Circuits

In deciding whether or not to include a certain type of computing element in the machine, the frequency of occurrence of that computing operation must be balanced against the time taken for the machine to obey a sub-programme designed to carry out the operation. Thus, special circuits are provided to perform addition, subtraction, multiplication and certain logical operations, but a sub-programme is used to perform division.

The component elements of the computing and other circuits used are similar to those used in video-pulse circuits in radar[3]. As an example, it will therefore be sufficient to consider schematically one type of adding circuit. The rules of binary addition are such that

$$x + y + w \geqslant 2 \text{ implies a 1 in } w',$$
$$x + y + w < 2 \text{ implies a 0 in } w',$$

and

$$x + y + w - 2w' = z,$$

where x and y are corresponding digits of the numbers to be added; w' is the carry digit; w is the carried digit (that is, w' delayed by one digit period); z is the sum digit; and x, y, w', w and z are represented by zero or unit amplitude pulses.

These rules are conveniently obeyed by the circuit shown schematically in Fig. 3, the important elements being the two amplitude discriminators, P and Q. These are arranged to deliver an output pulse during a digit period, if the sum of the pulses in the input pulse trains during that period is equal to or greater than 2 and greater than 0 respectively. Discriminator P determines whether a 1 is to be carried, and discriminator Q delivers the output z.

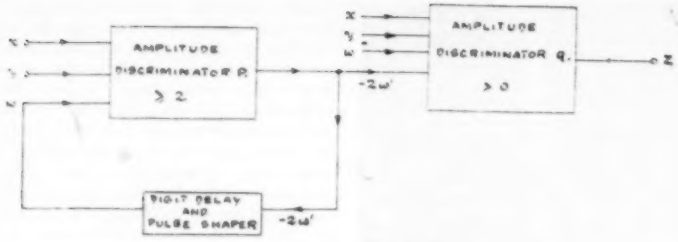


Fig. 3. Schematic of adding circuit

A subtracting circuit may be constructed in a similar manner to obey the rules of subtraction.

In multiplication* the 80-digit product is formed by repeated addition to a running total of the multiplicand, which is suitably shifted (delayed in time) for each 1 in the multiplier.

In addition to these arithmetical circuits, it is useful to be able to operate on data digit by digit, carried digits being suppressed. For this purpose circuits which are much simpler than those mentioned above are provided to perform the logical operations 'and', 'or' and 'not equivalent to'.

Associated with the computing circuits is a storage tube called the accumulator, which holds sufficient lines (two) to record the partial answers. An elementary computation is, in general, performed upon a number, x, obtained by reading the accumulator, and a number, y, obtained by reading a selected address in the main storage. The answer, z, is written into the accumulator over the previous contents, x. At any desired stage of the solution, a partial answer may be read from the accumulator and written into a selected line of the main storage, as a result of a suitable instruction.

The Machine

The most important remaining feature of the machine is the control of the order in which the instructions contained in a programme are obeyed, and this is now described, with reference to the schematic diagram of the machine, shown in Fig. 4.

On the left of the figure is 'Control' C, an electronic storage tube, holding two lines, which operates in conjunction with an adding circuit. When a new instruction is required from the instructions stored in one of the main electronic storage tubes, a 'prepulse' initiates a standard sequence of events. Initially, unity is, in general, added to the control instruction line of C (CI), and the new content of CI controls the 'staticisor', S. The new, or 'present', instruction (PI) is then selected from the main electronic storage, and written on the PI line of C, as a result of the condition of S. During this initial phase of the operation, the content of CI has operated as an instruction to extract the next present instruction from the storage. During the final phase of the operation PI, not CI, controls S. Thus, in general, PI selects a line of the storage, and causes some function to be performed on the contents of that line. When the present instruction has been obeyed, a further prepulse is given automatically, and the standard sequence is repeated. The time elapsing between adjacent prepulses is, except when multiplying, 1·8 m.sec.

It will be understood that the effect of adding unity to CI, after each prepulse, is to cause the instructions in a programme to be obeyed sequentially. Although, in general, this is required, some alternative must be available, if only to prevent instructions being consumed and made redundant at the rate of about 500 per sec. In fact, the same instructions are used repeatedly during the solution of a problem, and this is made possible by having the facility called 'transfer of control', by which the place in the list of instructions, as 'remembered' by CI, can be changed when desired. Such a transfer may be unconditional or conditional. In the unconditional case, use is made of one of two instructions which cause a chosen number to be read from the main electronic storage, and either written over or added to the content of CI. In the conditional case, the programme is arranged so that the sign of the content of the accumulator, A, as determined by a 'test' instruction, is the criterion. (A negative number $-q$ is represented by $2^{40}-q$.) If the content of A, which is indicative of the present state of the solution, is positive or zero, unity is added to CI after the next prepulse, in the normal manner. If, however, the content is negative, 2 is added to CI at this time, and one instruction in the list is omitted. If this instruction, which may or may not be omitted, is one of the type which modifies CI, a branching point has been created in the list of instructions, and the branch taken is conditioned by the present state of the solution.

On the right of Fig. 4, the accumulator A and its associated computing circuits, any of which may be switched into play by appropriate instructions, are

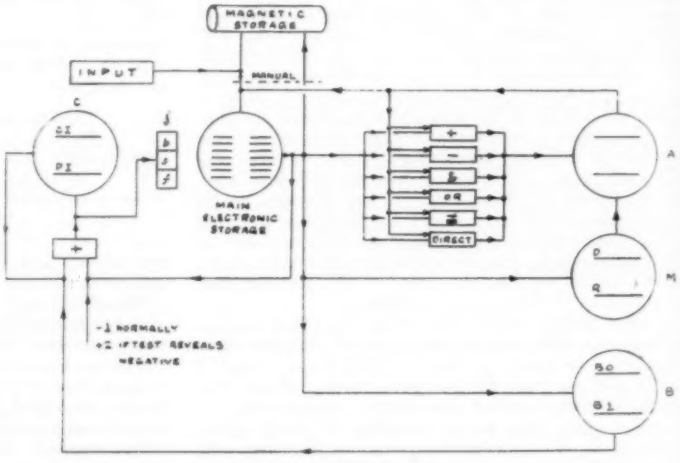


Fig. 4. The present machine

* The circuit used was developed by A. A. Robinson.

indicated. Multiplication involves the use of the tube *M*, the multiplicand being stated on the *D* line, and the multiplier on the *R* line. Products are added into the accumulator automatically.

Storage tube *B* is a valuable auxiliary to the machine and is used for modifying instructions. Instructions can, of course, be modified by the normal processes (*A* and *M*, etc.) in the same way as numbers, but this is often inconvenient and wasteful of time and storage space. Therefore each instruction (*s*, *f*) is preceded by a single digit called the *b* digit. If $b = 0$, the content of line *BO* of *B* (normally zero) is added into the present instruction as this instruction is written into the *PI* line of *C*, that is, before this instruction is used. If $b = 1$, the content of line *BI* of *B* is used in the same manner. Numbers are written into *B* from the main electronic storage, exactly as they are written into *M*, say.

Loading between the magnetic and electronic stores, and *vice versa*, is at present achieved manually.

Immediate future development of the machine will include the provision of more lines on the *B* tube, further extension of the capacity of electronic and magnetic stores as required, improved input and output facilities, and automatic interchange of information between electronic and magnetic stores.

I wish to acknowledge my indebtedness to Prof. M. H. A. Newman, and Mr. A. M. Turing for much helpful discussion of the mathematical requirements of digital computing machines; and to Mr. G. C. Tootill, who has collaborated in the design of the machine.

[1] Williams, F. C., and Kilburn, T., *J. Inst. Elect. Eng.*, **96**, Pt. III, No. 40 (March 1949).

[2] Unpublished work by J. C. West and G. E. Thomas. For a description of a similar system, see Booth, A. D., *Electronic Eng.* (July 1949).

[3] Williams, F. C., *J. Inst. Elect. Eng.*, **93**, Pt. IIIA, 303 (1946).

FORESTS AND MAN

A SERIES of five papers under the title of "Forests and Man" were read during the British Association meeting in Newcastle on September 5 at a combined meeting of Section K (Botany) and K* (Forestry). Prof. H. S. Champion, chairman of Section K*, presided.

The earlier papers were chiefly concerned with the history of British forests, and the later ones dealt with forest conservation. Dr. K. B. Blackburn outlined the history of the study of prehistoric forests and showed how the technique of pollen analysis, based on the counting of pollen grains preserved in the peat, had proved a tool of progressively increasing usefulness in revealing the details of forest history. The details for northern England were illustrated from the results of the study of a deep peat from Broadgate Fell, Northumberland, with continuous deposits from the end of the ice age up to present times. Here the graphs of pollen percentages showed features similar to those described by Dr. H. Godwin for East Anglia: first, a forest of birch yielding somewhat to pine as the hazel comes into prominence; then elm and oak appear, followed by a conspicuous rise of alder in a country now dominated by forest; later elm falls off; and afterwards a decline in tree cover is shown by proportionally large amounts of the pollen of herbaceous plants. The northern diagram differs, however, in having, throughout, larger quantities of birch and much smaller quantities of oak. Lime is very poorly represented, and beech and hornbeam are absent. In other northern deposits the percentages of pollen of pine, elm and oak may differ considerably, but the general trend of the curves for individual trees remains the same and may safely be put down to climatic changes.

Dr. Verona Conway introduced the question of the influence of man on the forests as shown by pollen analyses from three different localities. She first described how Iverson correlated charcoal layers found in Danish peats with changes in the vegetation: a fall in amount of tree pollen due to the fire was followed by a rise in hazel, birch and alder, at the expense of oak, with accompanying weeds of cultivation, such as ribwort plantain, and some cereal grains. Later, oak recovered. This was associated with the activities of the Neolithic farming people. Her second example was from Dr. Godwin's work at Hockham Mere, Breckland. Here, at the horizon where elm falls off in quantity, the sudden increase of herbaceous pollen indicates a reduction in forest at a period earlier than normal. This again can be associated with the arrival and activities of Neolithic man. Lastly, Dr. Conway referred to her own work at Ringinglow Bog, near Sheffield, where the sudden increase of herbaceous pollen was later, and by careful calculation of depths, worked out as being at A.D. 1100–1200. This probably corresponds to the appearance of sheep farming associated with the wool trade carried on by the nearby Cistercian monastery.

Dr. Frank Darling followed with a paper on "The History of the Scottish Forests". He explained that, though the fate of the early forests was due to the encroachment of the mosses, the disappearance of the later forest could be put down to a series of human activities. First, the Hallstadt Celts cleared around their living places on the coast and eastern plain, and the Romans destroyed trees as a military measure. Forests in the north and west remained; the Vikings in the ninth to the eleventh centuries burnt these from the coast; but perhaps the greater destruction was in the exploiting of forests to obtain timber for shipbuilding, and later charcoal for iron smelting.

The southern uplands were cleared in the fifteenth century with the introduction of sheep farming. North of the Clyde this did not begin until 1760, and in Ross not until early in the nineteenth century. Lastly, forest was cleared to get rid of wolves and to round up Jacobite fugitives. Nowadays, only small areas of natural birch and oak wood remain, and the pine forest with characteristic undergrowth is reduced to a few hundred acres.

Planting began in the early eighteenth century when the Countess of Seafield put in twenty million trees, but even now planted forests cover a relatively small area. Dr. Darling urged that the time is ripe for the land to go back to a forest continuum, as the sheep have been there too long.

Dr. C. Jacquiot, of Fontainebleau, then considered the question of forest conservation. He contrasted the traditional definition used in the Forest School at Nancy, "the keeping of the forest identical to itself forever as considered in time and space", with the simple one of maintenance of forest on wooded land.

Study of the biological reserves in the Forest of Fontainebleau has helped to arrive at a scientific basis of conservation of the less rigorous type. This forest reserve consists of various ages and species of

trees, with characteristic undergrowth. The fallen trees have their own flora and fauna with very precise needs and associations. In undisturbed forest there is little mineral loss, for all is returned to the soil. High forest under tree selection management looks very similar, but lacks the flora and fauna associated with fallen logs. The community may, however, be as stable as the natural one if no species is felled to abnormal scarcity and the stand is not over-cut. This and also even-aged high-forest management chiefly differ from natural forest in that the forester removes dead wood, instead of the fungi and insects doing so. The removal of the timber in temperate climes does not deplete the mineral reserves unduly, since the ash content of wood itself is low. On the other hand, small-sized branches have a greater mineral content owing to the higher proportion of living cells, and their removal may, for example, deplete the phosphorus content of the soil unduly. Dr. Jacquiot finally concluded that the high-forest system, with as long a revolution as possible, shows itself as the best method of forest conservation; coppice with standards can be used on good soils, but ordinary coppice is fundamentally a bad system.

Dr. R. Maclagan Gorrie discussed the Western Punjab to illustrate the necessity for conservation of forests. He thinks that forests do not actually alter the rainfall but they help to retain the moisture, and on the removal of forest the place becomes too dry. Crops such as tea, coffee and cocoa do not take the place of forest as the plants are widely spaced and so the ground becomes liable to erosion. Dr. Gorrie illustrated by lantern slides some conspicuous failures in conservation due to grazing, fire and continuous lopping of branches. Re-afforestation in arid countries is difficult but not impossible. Methods of proved worth are trenching along contours, terracing with the aid of bulldozers, check dams in the nullahs and other ways of controlling run-off of water. Shelter belts and hedgerows are necessary. *Tamarix articulata* and *Melia azedarach* are useful for this purpose.

For the actual planting, the land can be prepared by kans grass (*Saccharum spontaneum*) or barber grass (*Eulaliopsis binata*), and then shisham (*Dalbergia sissoo*) follows. In one case, a Mexican species *Prosopis juliflora* planted many years ago has proved a most successful forest tree.

KATHLEEN B. BLACKBURN

UNIVERSITY OF MALAYA

ON October 8 the University of Malaya was officially founded, and Mr. Malcolm MacDonald, Governor-General of Malaya, installed as the first chancellor. The colourful ceremonies at Singapore and the messages of goodwill from the universities throughout the Commonwealth, welcoming this latest arrival into the British academic family, mark the end of a beginning that dates from 1819. Stamford Raffles, in the vision he had of Singapore, urged that it should include a centre of learning and intellect, a "monument of light". "Shall we not consider it one of our first duties to afford the means of education to surrounding countries and thus render our stations not only the seats of commerce but of literature and the arts?" Raffles Institution, now a secondary school, and Raffles Museum and Library, which has been a government establishment since 1878, represent parts of the realization of Raffles's vision; but the direct parentage of the new University is to be found in the College of Medicine and Raffles College.

The College of Medicine, opened in 1905, adopted the name King Edward VII Medical School in 1912, altered to College in 1921. A government institution, it has been an integral part of the government medical services throughout its existence. It early won a high reputation, and its medical diploma has been recognized by the General Medical Council as a registrable qualification since 1916. It has had a dental school since 1929, the awards of which are also registrable qualifications. The College has received important endowments, including that of the chair of physiology from the King Edward VII Memorial Foundation in 1912 and of the chairs of bacteriology and biochemistry from the Rockefeller Foundation in 1925. By 1939 it had eleven professors and thirty-five other teaching staff, and a student body of 158.

Raffles College was founded to commemorate the centenary of Singapore "with a view to laying securely the foundations upon which a University may in course of time be established". It was opened in 1928, as a non-government institution, and has provided diploma courses in science and arts, including economics, and postgraduate courses in education. In 1941 it had seven chairs and seven other teaching posts, and a student body of more than three hundred.

A commission on higher education in Malaya was appointed by the Secretary of State for the Colonies in 1938. Its members, Sir William McLean and Dr. H. T. Channon, presented their report in June 1939, recommending that the College of Medicine and Raffles College should be fused into a University College of Malaya. Before decisions could be reached on the Commission's proposals, the War began. Malaya was in enemy occupation, Raffles College was used as Japanese military headquarters and the College of Medicine converted into a centre for the large-scale production of vaccine and serum. Most of the staff were captured and interned; school education almost ceased for four years. After liberation in September 1945, the surviving staff achieved a very rapid rehabilitation of the two Colleges; the College of Medicine was opened in June 1946, and Raffles College four months later, after the Allied military authorities had vacated the premises. The structures of the buildings of both Colleges were intact; indeed, the Japanese had usefully added a wing to Raffles College. The libraries had survived; but much of the equipment and furnishings had gone.

During the War, university education in the British Colonies had been reviewed by an authoritative commission under the chairmanship of Sir Cyril Asquith. A member of the Asquith commission, Dr. (now Sir) Raymond Priestley, vice-chancellor of the University of Birmingham, who had also served on its West Indies committee, was invited to visit Malaya in 1946 to explain the principles and policy formulated by the commission and to advise on their local application. As a result of his visit, a principal-designate of the proposed university college, Dr. G. V. Allen, formerly principal of the College of Medicine, was appointed, and a full commission, under the chairmanship of Sir Alexander M. Carr-Saunders, visited Malaya in March–April 1947. The commission decided that the two Colleges had so firmly established their academic standards that it

was unnecessary for them to pass through an interim phase as a university college, and they should be at once amalgamated into a university with degree-granting powers. The full report of the commission was published in 1948; its recommendations, both general and detailed, met with immediate acceptance by Governments, by the Colleges and by public opinion. Within a year, the necessary legislation had been enacted and administrative arrangements completed, and October 8, foundation day, has seen the ceremonial inauguration of the new, autonomous University under Dr. Allen as its first vice-chancellor.

It is proposed that later the University should move to a new site and buildings on the mainland. The British Government has promised a gift of a million pounds from Colonial development and welfare funds towards this project, and the University has launched an appeal. Pending removal to a new site the University is using the existing accommodation of the two Colleges and is undertaking a vigorous expansion of staff, library and equipment resources.

Situated at the junction of some of the great seaways and airways of the world, where many races, cultures and traditions are intermingled, the new University has the chance of making unique contributions to educational progress in South-East Asia, to the advancement of learning, by exploiting the rich variety of research opportunities in Malaya, and to academic co-operation between the East and the West. The "monument of light", of which Raffles dreamed, has been established. *Lumen floreat.*

NEWS and VIEWS

President and Vice-Chancellor, Queen's University, Belfast: Prof. Eric Ashby

BOTANISTS in particular will have read with pleasure that one of their number, Prof. Eric Ashby, Harrison professor of botany in the University of Manchester, has been invited by the Senate of Queen's University, Belfast, to accept the post of president and vice-chancellor—a worthy choice for a varied and exacting office. Prof. Ashby, who is forty-five, was a student at the Imperial College of Science and Technology and is a graduate of the University of London. His interest in plant physiology, genetics, statistical ecology and in the progress of botanical science generally, has taken him in turn to the United States (Universities of Chicago and Arizona) as a Commonwealth Fund Fellow in 1929, to a resumption of teaching and research at the Imperial College in 1931, to the University of Bristol as reader in botany in 1935, to the University of Sydney as professor of botany in 1938, and to the University of Manchester in 1946. These years saw the publication of several important series of papers in botanical journals, addresses on a variety of subjects, and a number of books including the thought-provoking work "Challenge to Education".

During his Australian period, administrative as well as academic duties fell heavily on Prof. Ashby's shoulders. He was at various times chairman of the Professorial Board of the University of Sydney and of the Australian National Research Council, director of the Commonwealth Scientific Liaison Bureau and a member of various Government committees. In 1944, as counsellor of the Australian Legation in Moscow and afterwards as chargé d'affaires, he had a unique opportunity of studying the progress of botanical science in the U.S.S.R. and the personalities of some of its principal exponents. His observations have appeared as authoritative articles in the columns of *Nature* and have been appreciated by a wider public through the medium of his readable and entertaining book "Scientist in Russia" and a notable broadcast on Lysenko. Since going to Manchester, Prof. Ashby has done much to reorganise, develop and modernize the Department of Botany, to recruit teaching and research staff, and to inaugurate new lines of investigation, while his own experimental work on leaf-shape has already shown fruitful results. In order to establish the reorganised Department on a firm footing, he has deferred acceptance of the new appointment until September 1950. Friends and colleagues will combine in wishing him every success in his new post.

Royal Institution: Prof. E. N. da C. Andrade, F.R.S.

ON January 1 next, Prof. E. N. da C. Andrade will take up his duties as director in the Royal Institution, resident professor and director of the Davy Faraday Research Laboratory, duties for which few English men of science can be so well fitted. Prof. Andrade received his early academic training at University College, London, and gained research experience at Heidelberg, Cambridge and Manchester, leaving Rutherford's laboratory in the last-named University to serve with the artillery in France during the First World War. While professor of physics at the Artillery College, Woolwich, during 1920–28, he produced no less than three editions of "The Structure of the Atom", a book which showed him to be a first-rate scientific writer. He was appointed Quain professor in the University of London in 1928, the post which he will shortly vacate. In the laboratories at Gower Street, he found a long-awaited opportunity to show his creative genius as an experimenter with a truly remarkable flair for fundamental and striking experiments in properties of matter, with particular reference to the structure of metals and the flow of liquids. His work was recognized by election to the Royal Society in 1935. It was interrupted by war service as scientific adviser to the Director of Scientific Research, Ministry of Supply, and he eventually returned to a badly damaged, almost non-existent, research laboratory which, with characteristic energy and determination, he managed to resuscitate in an amazing way. He was fittingly awarded the Holweck Prize and Medal in 1947 and made Chevalier of the Legion of Honour this year. A brilliant lecturer, a poet of distinction, a great authority on the history of science, a man of affairs and a warm-hearted friend, the new director and his charming wife will take much to the Royal Institution.

Charles Chree Medal of the Physical Society: Dr. G. M. B. Dobson, F.R.S.

THE 1949 Charles Chree Medal and Prize of the Physical Society will be presented to Dr. G. M. B. Dobson, of Oxford, on November 4, at a meeting to be held at the Science Museum, Exhibition Road, London, S.W.7, at 5 p.m. Dr. Dobson has been eminent in the meteorological field for many years,

and was awarded the Symons Gold Medal of the Royal Meteorological Society in 1938. Since then he has been engaged in investigations of the relationship between changes in weather and the humidity and ozone content of the stratosphere. During and since the War he has been investigating the formation of ice in the atmosphere, a problem of great importance to pilots from the point of view of condensation trails. In his lecture, which follows the presentation, Dr. Dobson will recall some personal memories of Dr. Chree, and will then speak on the subjects mentioned above.

British Society for the Promotion of Vegetable Research

A STATION for research in vegetable production in Great Britain has now been established under a governing body constituted as a company limited by guarantee and without a share capital, with the title of the British Society for the Promotion of Vegetable Research. For the funds for its work, the Society will at the outset depend on grants from the Ministry of Agriculture (for stations in Scotland, from the Department of Agriculture for Scotland). The Agricultural Research Council will exercise general scientific guidance and will supervise the work and staff of the Society. The members of the governing body—twenty-three in number—include nominees of the Ministry of Agriculture and the Department of Agriculture for Scotland, the Department of Scientific and Industrial Research, various learned societies, universities and institutions concerned with horticulture, vegetable producers large and small (through the National Farmers' Union and that of Scotland, and the National Allotments and Gardens Society) and trade interests. The chairman of the Society is Prof. F. T. Brooks, of the University of Cambridge, and the director of the research station is Dr. James Philp (see *Nature*, **161**, 715; 1948). The headquarters research station will be at Wellesbourne, Warwickshire (where the registered office of the Society will also be situated), and consists of 280 acres of deep sandy loam over gravel or keuper clay; the land is being purchased by the Ministry of Agriculture and will be leased to the Society. The site is admirably suited to research on vegetables; but some time must necessarily elapse before buildings and equipment can be provided, staff engaged and the farm generally developed for research purposes. The Ministry is also leasing to the Society 150 acres of land which it owns at Paglesham, Essex, for a sub-station primarily to be used for the multiplication of stocks of seed of vegetables bred at the main station or elsewhere. A second sub-station is the former Horticultural Research Station at Cambridge, which has been taken over from the University of Cambridge, and the staff of which will continue to work there until they can be transferred to the headquarters station.

Indian Phytopathology

WITH the rapid advances made in mycology and plant pathology throughout India during the past quarter of a century (since the late Sir Edwin John Butler was appointed the first Imperial mycologist at the Pusa Agricultural Research Institute) the time was fully ripe for the publication of a journal devoted to the interests of the Indian Phytopathological Society. In introducing the first number of the journal, entitled *Indian Phytopathology*, the president of the Council, Mr. J. F. Dastur, hopes that a still closer association and relations will be effected among members of the Society and other scientific workers, both in India and abroad. The interests of the Society extend over six areas or zones, namely, the northern Delhi, eastern, western, central and southern, and are watched over by Dr. Pushkarnath, Dr. Vasudeva, Dr. Mehta, Dr. Uppal, Mr. Kulkarni and Mr. K. M. Thomas respectively.

The editorial board consists of the well-known pathologists Dr. B. B. Mundkur (editor-in-chief [see p. 680 of this issue]), Dr. S. R. Bose, Dr. M. K. Patel, Dr. R. K. Saksena and Dr. R. S. Vasudeva. The first number of the journal, consisting of ninety-six pages, is devoted to valuable contributions of high standard on a wide range of topics. The journal is beautifully printed and illustrated on good quality paper. The annual subscription is Rs. 14 (one guinea) post paid. There will be, for the present, two issues in a year, comprising about 250 pages; but the number of pages and issues per annum will be gradually increased. Subscriptions should be sent to the Secretary-Treasurer, Indian Phytopathological Society, Pusa Buildings, New Delhi.

World Crops: A New Monthly Journal

SINCE the Second World War, attention has been increasingly focused on the international aspect of agricultural problems, and the appearance of a new monthly journal, *World Crops*, published by Leonard Hill, Ltd., under the editorship of Sir Harold Tempany, is appropriate. The scope of the journal is wide, embracing the cultivation, protection, storage and handling of many essential crops, and their processing for food, fodder and industrial products. Its purpose is to describe, in not too technical language, the results of research, and to discuss such current topics and problems as will interest both the grower and manufacturer as well as the administrator and scientific worker. Among the outstanding world agricultural problems of to-day is the necessity for increasing the production of rice and vegetable oils and to find means for controlling the disease that threatens the cocoa industry. Authoritative articles dealing with these subjects appear in the first number, issued in September 1949. The prospects for the extension of tobacco production in East and Central Africa are also discussed, and an account is given of the project of the British Overseas Corporation for the growing of sorghum and the setting up of piggeries in Queensland, Australia. Items of general interest include an article on agricultural education and reports of recent important conferences and meetings. Good illustrations are evidently intended to be a feature of the new journal; the subscription rates are, one year 25*s*., two years 40*s*., and three years 50*s*.

Vegetation Maps of Switzerland

THE Phytogeographical Committee of the Swiss Society of Natural Sciences has planned, and Dr. Emil Schmid prepared, a vegetation map of Switzerland to a scale of 1 : 200,000 or about three miles to the inch. The map is issued in four folded sheets of which two, Nos. 1 and 4 of the series, have so far been received. No. 1 covers the north-west sector including Bern, Neuchâtel, Basel and Aarau, and No. 4 the south-east sector or the Gotthard–Tessin–Graubünden area. Eleven primary types of vegetation are recognized. These are shown in different colours, with the chief associations in each type differentiated by symbols indicating the dominant species; the

extents of arable cultivation and grassland within each primary vegetation type are also indicated. The associations shown are for the most part forest types, the twenty-two symbols representing dominants all referring to trees and shrubs. The maps are thus particularly valuable as showing at a glance the types and detailed distributions of woodlands and their relation to topographical features and geographical location. The utility of these finely printed maps to botanical visitors will be considerable, though place-names are not easy to decipher beneath the superimposed colours and symbols. The legends and keys are given in French and German, and each map measures 37 in. by 26½ in. They are printed on stiff paper by Kümmerly and Frey of Bern and are obtainable from Hans Huber of Bern at a cost of 12 Swiss francs each.

Ancient Fishing on the River Severn

THE interest in folk museums is growing throughout Great Britain. There are those who would like to see immense parks set aside for folk studies on a national scale on the Scandinavian plan, whereas others are content with more regional establishments, even down to a county basis; but no folk museum of any kind will be of the slightest value unless its collections provoke study and subsequent publication. It is for this reason that a modest little work, "Guide to the Severn Fishery Collections", by J. Neufville Taylor, which has been published by the City of Gloucester Folk Museum, is to be commended, and it is to be hoped there will be many more like it. The various methods used on the River Severn to catch the different fish required will also be of interest to fishermen, even to those who despise all methods except that of the rod, fly and line.

The European Bison

IN recent years, the Society for the Preservation of the Fauna of the Empire has taken keen interest in the efforts made by the International Society for the Preservation of the Wisent [European bison] to save this remarkable relative and possibly forbear of the American bison from extinction. Its ultimate survival is still open to doubt and, in the July issue of the *Journal of the Society for the Preservation of the Fauna of the Empire*, is assembled the latest information procurable on the status of the species. Prof. Jan Zabinski and Miss Erna Mohr contribute authoritative articles from different points of view, and these are prefaced by extracts from a recent paper of Mr. Richard Glover's which both summarizes the known history of the wisent and deals with its contrasts to and similarities with the American bison. If suitable action is taken, there seems to be reasonable hope that the wisent may survive under protection in the right conditions of forest space to bring its numbers up to those which existed before the First World War.

The Molluscan Stomach

IN continuation of his studies on the alimentary canal of Mollusca, Prof. A. Graham has described the stomach of typical lamellibranchs and prosobranch gastropods, discussed the functions and homologies of the parts and compared them with those of the Polyplacophora and Cephalopoda ("The Molluscan Stomach", by Alastair Graham. *Trans. Roy. Soc. Edin.*, **61**, Part 3, No. 27; 1949). The molluscs considered range from the ciliary-feeding microphagous lamellibranchs to the browsing macrophagous gastropods; but only to the more primitive members of the latter class, which exhibit, at least in the trochids, a close resemblance to the lamellibranch type of stomach, with its style sac, major and minor typhlosoles, cæcum, grooved sorting area and gastric shield. A simplification of this structure is to be expected in carnivorous gastropods, and does, in fact, occur. One effect of torsion on the primitive form of the stomach is the displacement of the œsophagus from an anterior to a posterior position, so that eventually, in tectibranchs and pulmonates, the œsophageal and intestinal openings are adjacent to one another, and as a result the stomach itself becomes a cæcum receiving the ducts of the digestive gland. The stomach of *Patella* is peculiar in that it is small, ill-defined and devoid of a cæcum or gastric shield, but it possesses two typhlosoles. The paper is illustrated by twenty-three figures of outstanding merit, prepared by a skilled use of scraper board combined with mechanical stippling.

The Backward Adult

IN the latest of a series of articles in *Army Education* (**23**, No. 2; June 1949), Dr. W. D. Wall describes the case studies he has made with backward men. His inquiries with adults are supported by investigations which have been made with groups of backward children in schools and show that the majority of the educationally retarded are below the general level of the population in intelligence; any group of poor readers is likely to contain between a half and two-thirds of men whose level of intelligence is sub-normal. On the other hand, there are many near-illiterates whose mental level is nearly normal or even supernormal. Some of these often have difficulty in distinguishing the shapes of similar letters like *b* and *d*, *m* and *n*, *p* and *q*. In other cases there is a tendency to reversals, either of single letters or of words, showing that the habit of attacking a word from left to right is not established. Some backward adults of average intelligence have marked difficulties in recalling material presented aurally or visually, or in synthesizing into whole words syllables which can visually or auditorily be discriminated quite well. A third class of defects is physiological, and, in a group of a hundred backward readers studied by Wall, defects of hearing and vision were nearly twice as frequent as among a group of normal readers of otherwise comparable background. Speech defects—stammering, lisping and marked hesitations accompanied by disturbance of breathing—and left-handedness or a tendency towards it also seem to operate as handicaps in learning. The factor which, apart from intelligence, is of greatest significance in leading to backwardness is that of personal adjustment. In Wall's inquiries nearly two-thirds of the men showed that they were not adjusting themselves to the demands of even a relatively simple existence. It is, however, difficult to estimate how far emotional disturbances during and after school life inhibit learning and how far educational failure contributes to adult maladjustment.

Measuring Productivity

THE 1948–49 Winter Proceedings of the British Institute of Management have been presented as a report. The fourth meeting was addressed by Sir Ewart Smith and Dr. R. Beeching who, in a joint paper, discussed the means of measuring the effectiveness of the productive unit. After defining the meaning of

productivity, the authors elaborate the factors affecting it and the problems of measurement. To arrive at a true measure of effectiveness, it is necessary to make allowance not only for the number of personnel engaged in the unit under examination but also for the invisible men who serve the unit externally in the supply of the necessary capital equipment, raw materials and other services. Sir Ewart and Dr. Beeching also consider that Marshall Aid distorts the productivity picture. The present rate of this aid is equivalent to the wages of 750,000 industrial workers at current British wage rates, and since "the total number engaged in industrial production in Gt. Britain is some 10,500,000, Marshall Aid is equivalent to an increase in our industrial production of 7 per cent as a first approximation". Among points which arose in discussion were the problem of plant valuation and the need for individual firms to give more thought to the question of labour incorporated in capital equipment. The report may be obtained from the British Institute of Management, 17 Hill Street, London, W.1, price 2*s.* 6*d.*

Abstracting Journals

A LIST of Periodicals and Bulletins containing abstracts published in Great Britain has been prepared under the supervision of the Abstracting Services Consultative Committee and issued by the Royal Society (London: Camb. Univ. Press. Pp. 62. 2*s.* 6*d.*). The periodicals are listed alphabetically by title with explanatory notes, and there is a further classified list under the following heads: agriculture, botany, food and nutrition; biology; chemistry, chemical industry and mineralogy; engineering; electrical engineering; medicine; metallurgy; miscellaneous industries; physics, geology and meteorology. An index to the names of institutions, societies and other publishers is included, and a partial list of journals containing abstracts published in the British Commonwealth is appended. Information on omissions, particularly of abstracting bulletins of industrial concerns, is invited, for possible incorporation in future editions.

Institution of Naval Architects: Awards

THE Institution of Naval Architects has recently announced the following awards for 1949: 1851 Exhibition commissioners postgraduate research scholarship in naval architecture (£500 per annum for two years) to I. M. Yuille, University of Glasgow; Aluminium Development Association research scholarship in the application of light alloys to ship construction (£400 per annum for two years) to J. B. Caldwell; Martell scholarship in naval architecture (£175 per annum for three years at the Royal Naval College, Greenwich) to J. W. Goymer, H.M. Dockyard, Sheerness; Earl of Durham prize, in connexion with the examination for the Martell scholarship in naval architecture, to S. Faulkner, H.M. Dockyard, Devonport.

Awards of National Certificates in Textiles

OF a total of 298 students who took the examinations this year for the award of national certificates in textiles, 230 students were successful, 157 having studied cotton subjects and 73 woollen and worsted processing. This is the highest number of successes so far obtained since the inception in 1935 by the Textile Institute and the Ministry of Education of the scheme for the award of certificates. The corresponding number last year was 195, and the highest pre-war total was 186. The awards this year are divided as follows: for the ordinary national certificate, 205 candidates sat and 150 secured awards; of 93 students seeking the higher national certificate, 80 were successful. The former certificate entails three years of study and the latter five years.

Announcements

PROF. W. L. WATERHOUSE, research professor of plant pathology and agricultural botany in the University of Sydney, has been awarded the Farrer Memorial Medal for 1949 in recognition of his work on wheat diseases and their control.

THE Lord President of the Council has appointed the following to the Advisory Council for Scientific and Industrial Research for five years from October 1, 1949: Mr. A. H. Wilson, since 1945 director of research and development of Messrs. Courtaulds, Ltd.; Mr. A. H. S. Hinchliffe, governing director of Glazebrook Steel and Co., cloth merchants and exporters, of Manchester; Lord Halsbury, managing director of the National Research Development Council; and Prof. R. S. Edwards, of the London School of Economics, who has recently made a comprehensive study of research associations. The new members succeed Mr. W. F. Lutyens, Mr. W. J. Drummond, Sir Henry Guy and Sir William Halcrow, who have retired on the completion of their appointments.

MR. N. A. W. LE GRAND, until recently secretary and commercial administrator of Messrs. J. D. P. Wheatley and Co., has been appointed secretary of the British Welding Research Association, in succession to Mr. A. Barker, who has joined the staff of the British Boot and Shoe Manufacturers' Association.

UNDER the auspices of the Linnean Society of London, in conjunction with the Systematics Association, a course of lectures and demonstrations on "The Practice of Botanical and Zoological Classification" will be given in the rooms of the Linnean Society, Burlington House, London, W.1, on the following dates: October 26, November 9, 23, January 25, February 8, 22, March 8 and May 6. The meetings, which are open to advanced students of biology, will begin at 4.30 p.m.

APPROXIMATELY thirty-one post-doctorate fellowships will be offered by the National Research Council of Canada for the year 1950–51, eighteen of which will be awarded in chemistry, three in atomic energy research, and about ten in physics. The stipend is 2,820 dollars per annum, tax free, and is supplemented by travel grants for successful candidates from abroad. While appointments at the Atomic Energy Project, Chalk River, are restricted to Canadian citizens and British subjects, applicants of all nationalities are invited for the Divisions of Chemistry and Physics. Application forms (to be received in Ottawa not later than February 15, 1950) can be obtained from the Secretary, Laboratories Awards Committee, National Research Council, Ottawa, Canada, or from the Chief Scientific Liaison Officer, National Research Council of Canada, Africa House, Kingsway, London, W.C.2, England.

ERRATUM. In *Nature* of October 8, p. 606, Prof. S. Zuckerman was incorrectly described as professor of anatomy and physiology in the University of Birmingham. Prof. Zuckerman is professor of anatomy; the professor of physiology is Prof. H. P. Gilding.

PHOSPHORYLATION OF *d*-GLUCOSAMINE BY BRAIN EXTRACTS

By R. P. HARPUR* and PROF. J. H. QUASTEL, F.R.S.
Montreal General Hospital Research Institute, Montreal

DURING an investigation into the relationship between acetylcholine synthesis and carbohydrate metabolism in the central nervous system, it became important for us to study the inhibitory action of glucose and fructose on the rate of acetylcholine formation by extracts of acetone-dried brain powders. Acetylcholine synthesis in such extracts and in homogenates proceeds rapidly under anaerobic conditions provided adenosinetriphosphate is present[1,2]. Feldberg and Mann[1] also reported an inhibitory action of hexoses on this process. They made the suggestion that the sugars exercised their effects by being phosphorylated at the expense of adenosinetriphosphate, the quantity of the latter thus being diminished and the rate of acetylcholine synthesis being correspondingly decreased.

Using the manometric technique of Colowick and Kalckar[3], we have been able to show that glucose and fructose are phosphorylated at the expense of adenosinetriphosphate in the presence of the brain extracts and to correlate this reaction with the inhibition of acetylcholine synthesis. While this work was in progress, Wiebelhaus and Lardy[4] reported observations on the phosphorylation of glucose and fructose by acetone powder extracts of beef brain. They showed also that glucose has a higher affinity than fructose for the phosphorylating system. Meyerhof and his co-workers[5,6,7] have carried out extensive studies on brain homogenates which show that glycolytic rates and hexokinase activities for glucose, and particularly for fructose, are dependent upon adenosinetriphosphate and sugar concentrations.

We now wish to report that *d*-glucosamine is phosphorylated at the expense of adenosinetriphosphate in the presence of extracts of acetone-dried brain and that, like glucose and fructose, it also produces an inhibition of the rate of acetylcholine synthesis in these extracts. Further details of this inhibition will be given in a later publication[8]. Relatively little is known of the metabolism of this important aminosugar, and the finding that it may be phosphorylated, according to manometric studies, by adenosinetriphosphate should stimulate further work on the subject. The finding is also of interest in view of the recent report of Jacobs[9] that serum glucosamine-levels are high in diabetes mellitus and that the levels are reduced during insulin treatment.

Beef brains were obtained from the abattoirs within thirty minutes of the death of the animals, and the grey matter was removed and ground in ice-cold acetone. After filtering, the resulting powder was stored in a vacuum desiccator in the refrigerator. The extracts were made with water and centrifuged. The somewhat opalescent centrifugate was used for phosphorylation studies. A quantity of centrifugate, corresponding to the extract of 45 mgm. of dry powder, was placed in a Warburg manometer vessel which contained a solution of salts giving a final concentration of 0·028 *M* $NaHCO_3$, 0·028 *M* KF, 0·004 *M* $MgSO_4$. The hexose or *d*-glucosamine was added at an appropriate concentration and sodium adenosinetriphosphate solution was placed in the side tube. Experiments were conducted at 27° C., and adenosinetriphosphate (final concentration 0·002 *M*) was tipped into the main vessel after twenty minutes equilibration and gassing with 93 per cent nitrogen : 7 per cent carbon dioxide. The final volume of fluid in the vessel was 3·0 ml. The rate of gas (carbon dioxide) output was measured in the conventional manner ; the rate is proportional to the speed of the reaction between hexose or glucosamine and adenosinetriphosphate. Two commercial preparations of glucosamine hydrochloride and one of the free base* were used ; all were found to give the same results. Control experiments which contained no sugar were always run, and the figures from these controls have been subtracted from the experimental figures to make a correction for the small adenosinetriphosphatase activity of the extracts and the change in gas volume when adenosinetriphosphate is tipped into the main vessel. It should be mentioned that, in the absence of adenosinetriphosphate, no gas output is observed from the sugars or *d*-glucosamine.

Phosphorylation of *d*-Glucosamine and Hexoses

Typical rates of gas output by glucose, fructose and *d*-glucosamine in the presence of 0·002 *M* adenosinetriphosphate, under the experimental conditions described, are shown in Table 1. It will be

Table 1

Substrate Molar conc.	μl. Carbon dioxide liberated at 27° C. Glucose Time in minutes from start of experiment. 5	10	15	Fructose 5	10	15	*d*-Glucosamine 5	10	15
0·0001	14	12	13	5	7	9	2	1	2
0·0002	18	23	23	8	12	18	5	6	8
0·0003	—	—	—	7	12	17	—	—	—
0·0004	—	—	—	9	17	22	4	10	13
0·0005	35	55	61	19	31	39	8	13	16
0·001	32	49	58	26	41	49	12	20	26
0·002	37	60	69	34	59	66	11	23	30
0·02	32	52	60	45	61	67	16	25	30

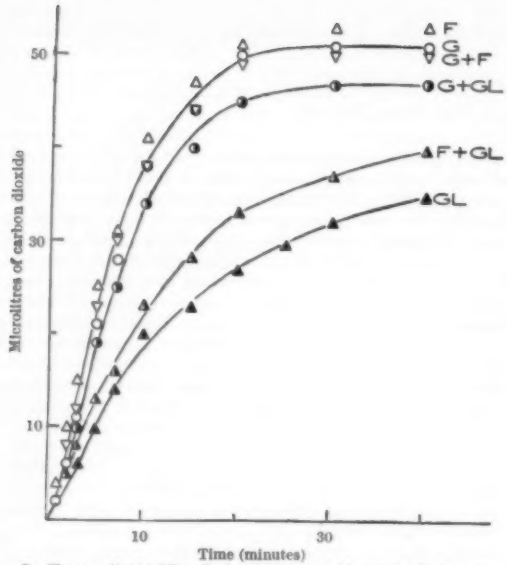
noted that with low concentrations of glucose, where the adenosinetriphosphate concentration is in no way limiting, the gas outputs in the first fifteen minutes approach the theoretical value for the conversion of glucose to hexosediphosphate. As pointed out by Wiebelhaus and Lardy[4], this makes the determination of K_M difficult by the manometric method. The maximum velocity of phosphorylation takes place at a lower concentration of glucose than that of fructose, while the speed of phosphorylation of *d*-glucosamine is appreciably less than that of fructose. Nevertheless, kinetic studies make it clear that the affinity of *d*-glucosamine to the enzyme involved is of the same order as that of fructose. Approximate values for the Michaelis constants are as follows : glucose $K_M = 0{\cdot}0001$, fructose $K_M = 0{\cdot}0007$, *d*-glucosamine $K_M = 0{\cdot}0006$.

Competition Between *d*-Glucosamine and Hexoses

Experiments with mixtures of the hexoses and *d*-glucosamine at appropriate concentrations indicate that no addition of the rates of phosphorylation

*Canada Packer Research Fellow (McGill University).

*d-(+)Glucosamine free base was kindly supplied by Ciba Co., Ltd. (Montreal).



G, Glucose (0·001 *M*); *F*, fructose (0·002 *M*); *GL*, *d*-glucosamine (0·002 *M*); *G+F*, glucose (0·001 *M*) + fructose (0·002 *M*); *G+GL*, glucose (0·001 *M*) + *d*-glucosamine (0·002 *M*); *F+GL*, fructose (0·002 *M*) + *d*-glucosamine (0·002 *M*)

occurs, and the results are consistent with a competition of all three substrates for the enzyme involved. The data shown in the accompanying graph bear out this conclusion. No correction, however, has been made for the acid-binding power of *d*-glucosamine. While there is only a slight inhibitory effect, if any, of *d*-glucosamine on glucose phosphorylation at the concentrations given, the presence of *d*-glucosamine reduces the rate of gas output due to fructose by far more than can be accounted for by acid-binding. It is evident that competition between all three substrates does occur, that between fructose and *d*-glucosamine being the most apparent. This would be expected from the fact that the affinities of these two molecules for the phosphorylating enzyme are of the same order.

Competitive Inhibition by N-Acetylglucosamine

The inhibition by *d*-glucosamine of hexose phosphorylation by adenosinetriphosphate might be interpreted as partly, if not wholly, due to competition not for a common enzyme but for the adenosinetriphosphate itself. This explanation is made unlikely by our finding that N-acetylglucosamine, which is not phosphorylated, since there is no gas output with adenosinetriphosphate under the experimental conditions described, exercises a large inhibitory action on the rates of phosphorylation of fructose and of *d*-glucosamine. Typical results showing the gas outputs obtained with mixtures of N-acetylglucosamine, at different concentrations, and glucose, fructose or *d*-glucosamine are shown in Table 2. It will be noted that N-acetylglucosamine brings about a relatively large inhibition of the rate of phosphorylation of fructose, the percentage inhibition being greater than that obtained with *d*-glucosamine. Its inhibitory effect on the phosphorylation of glucose is only perceptible at relatively high concentrations.

Table 2

Molar conc. of N-acetylglucosamine	μl. Carbon dioxide liberated at 27° C. Glucose 0·001 *M*			Fructose 0·002 *M*			*d*-Glucosamine 0·002 *M*		
	Time in minutes from start of experiment								
	5	10	15	5	10	15	5	10	15
0	32	49	58	28	48	56	10	19	26
0·001	—	—	—	9	16	21	9	15	21
0·002	—	—	—	2	6	8	3	8	12
0·003	—	—	—	4	7	8	3	9	12
0·004	—	—	—	3	5	5	3	7	9
0·008	20	35	45	1	4	4	—	—	—
0·012	15	29	36	—	—	—	—	—	—

These results are all consistent with the view that N-acetylglucosamine has an affinity for the enzyme involved in the phosphorylation of glucose, fructose and *d*-glucosamine. It seems strange that the enzyme which phosphorylates fructose at the expense of adenosinetriphosphate should also bring about a phosphorylation of *d*-glucosamine. Yet the inhibitory effects of N-acetylglucosamine on both processes make it difficult to believe that is not the case. The effects cannot be due to the N-acetyl group alone since acetylglycine has no adverse effect upon the phosphorylation of *d*-glucosamine.

Summarizing these results, it is evident that extracts of brain bring about a phosphorylation of *d*-glucosamine at the expense of adenosinetriphosphate, that glucose, fructose and *d*-glucosamine all compete for the phosphorylase involved, glucose having the highest affinity, and that N-acetylglucosamine, which is not phosphorylated, acts as a competitive inhibitor to all three substrates.

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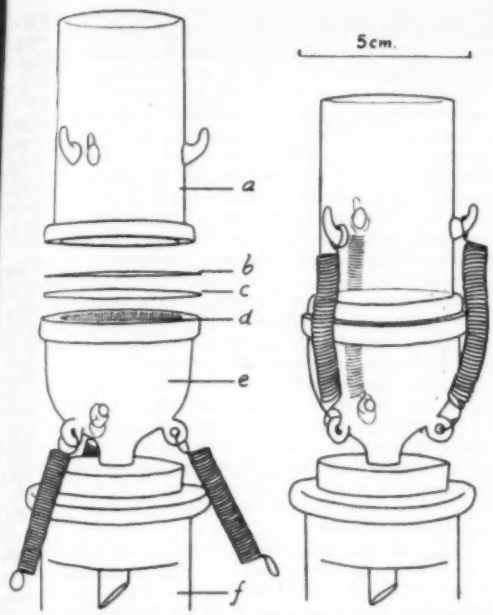
QUANTITATIVE ESTIMATION OF MARINE NANNOPLANKTON

By H. A. COLE and E. W. KNIGHT JONES
Ministry of Agriculture and Fisheries, Conway, N. Wales

AT a recent meeting of the Challenger Society our attention was directed to the need for a restatement of the technique for the estimation of nannoplankton flagellates and algæ. Appreciation of the importance of these very small forms as food for marine larvæ and filter feeders is growing, although little is known as yet of their distribution in the sea or of their seasonal variation in abundance.

The method successfully employed at Conway for the past fifteen years[1] is based upon the concentration of a known volume of sea water by filtration through a collodion membrane. The filtering apparatus used was formerly made in Germany; but Messrs. Baird and Tatlock, Ltd., have recently manufactured an improved model under the trade name 'Stefi'. The apparatus (see figure) comprises a cylindrical glass container (*a*) with an open ground bottom, which rests on the collodion membrane (*b*), which, in its turn, is separated from a sintered glass plate by a filter paper (*c*) (Whatman No. 3 is very suitable).



Filtering apparatus for the estimation of nannoplankton. (*a*) Cylindrical glass container; (*b*) collodion membrane; (*c*) filter-paper; (*d*) sintered glass plate; (*e*) funnel; (*f*) neck of filter flask

The sintered glass plate (*d*) is fixed in a small glass funnel (*e*), with the top ground level with the surface of the plate, the neck of the funnel passing through a rubber bung fixed in the neck of a filter flask (*f*). The upper container is held firmly in place by three small metal springs attached by glass loops to the side of the funnel and passing over hooks fused on to the side of the upper container. These springs are in slight tension, thus making a watertight joint between upper and lower parts of the apparatus.

To estimate the nannoplankton in a sea-water sample, the procedure we have found to be most satisfactory is as follows. The apparatus is assembled, the container and filter being washed with distilled water before use. 49 ml. of the sample is poured into the container and the filter flask connected to an exhaust pump (one fitted to a laboratory tap is quite adequate). Filtration is continued until the last trace of liquid just disappears from the surface of the membrane; the vacuum is then quickly released by disconnecting the pump, leaving the nannoplankton organisms as a film on the surface of the membrane. 1 ml. of the water under examination is then quickly added to the container by means of a graduated pipette delivering to the tip. With a fine sable brush the organisms on the membrane are lightly but thoroughly brushed off and mixed with the 1 ml. of liquid, which is then withdrawn with a 1 ml. teat pipette.

After shaking to mix the contents, drops of the concentrated sample are placed on three hæmacytometers and the covers placed in position. While the organisms in one chamber are being counted, the other two should be covered to exclude light.

We find it convenient to use hæmacytometers of 0·1 mm. depth with Thoma ruling, and to count the organisms in the four lines of squares which are divided by a central line, counting the organisms in 80 squares in each sample. The volume examined is therefore 1/50 ml., and since the sample has been concentrated 50 times this gives directly the number of organisms per mm.^{3} in the original sea water, the most generally useful expression of their abundance. Three counts are usually sufficient to give a reasonable degree of agreement between samples.

The membranes we have used are those made by the Wright-Fleming Institute of Microbiology, St. Mary's Hospital, London, and sold under the name 'Gradocol'; the most useful for general work are those of average pore diameter 0·6 μ. A membrane with smaller pores filters very slowly; this tends to allow a deterioration in the condition of the more delicate flagellates and so to increase the difficulty of making an accurate count. Filters with slightly larger pores would retain all the known flagellates and also most of the bacteria, but cannot be used because there is an appreciable loss by gravity while the 1 ml. concentrate is being mixed in the filtering apparatus and before it is withdrawn, resulting in still further concentration and artificially high counts.

Counting is done under a ⅙-in. objective, with a × 10 eyepiece (magnification 500), using daylight. Artificial light is not suitable since the recognition of colour is important; further, exposure to very bright light tends to immobilize many flagellates. For this reason samples awaiting examination or counting should always be placed in the dark. We have found it convenient to record the small diatoms and non-motile green and blue-green algæ separately and to divide the flagellates into three categories: those bigger than 10 μ (which are usually too large to serve as food for early marine larvæ), those between 2 and 10 μ, and those 2 μ and less in length.

Correctly applied, this technique leaves the flagellates in good condition, with a high proportion motile. In the hands of four separate operators, it has given reproducible results. The difficulties experienced result mainly from the very minute size of the organisms to be counted, and some experience of pure cultures of representative flagellates and green and blue-green algæ is needed before accurate counting is possible; in particular, it is essential to see and examine closely cultures of the 1–1·5 μ flagellates (shortly to be described by Dr. R. W. Butcher), which occur in every sample of sea water and may be abundant. Blue-green algæ of the genus *Synechococcus* are also extremely small (1–2 μ), but do not seem to occur very frequently. The separation of these two groups from bacteria and minute particles of detritus requires very close observation and a microscope with good lenses, and in particular an efficient achromatic condenser.

For densities of nannoplankton organisms substantially exceeding 100 per mm.^{3}, concentration of the sample is not absolutely necessary; but at lower concentrations this is essential to ensure a reasonable degree of accuracy. Since the recognition of these minute organisms must always be a difficult task, and many of them are extremely delicate, there will always be a chance of overlooking a few individuals in a sample. In a concentrated sample this will not reduce accuracy by more than a few per cent; but in an unconcentrated sample the whole field of a 0·1 mm. counting cell may only contain one to five organisms, and if one is overlooked the percentage error is very high.

We have examined a large number of sea-water samples from the estuary of the River Conway, the Helford River, Cornwall, the Rivers Crouch and

Roach, Essex, and from the oyster-breeding tanks of the Ministry of Agriculture and Fisheries at Conway and Lympstone, Devon. In the sea we have found concentrations varying from 5 to 70 organisms per mm.[3]; but under tank conditions densities up to 200 mm.[3] have been recorded, usually following enrichment of the water. Such high densities are accompanied by high *p*H and by much increased opacity of the water. The very high concentrations recorded in Loch Sween[2] must be treated with reserve, if only because of the statement that maximum densities (more than 2,000 per mm.[3]) were recorded from clear waters of normal *p*H. Such a combination is in practice impossible. Cultures of a wide variety of flagellates are maintained at this Station, and at densities of 2,000 per mm.[3], estimated without concentration, all these cultures are noticeably dense and coloured to the naked eye in small flasks. In the Conway tanks, with a depth of 2 metres, large objects are not visible on the bottom, except as blurs, if the density of nannoplankton organisms exceeds 100 per mm.[3].

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ROYAL PHOTOGRAPHIC SOCIETY
ANNUAL EXHIBITION

THE second part of the ninety-fourth annual exhibition of the Royal Photographic Society, which was opened on October 8 and continues until October 26, is devoted to scientific, Nature, record and technical subjects. This part includes about sixty exhibits, from studies of metals by radiography and the electron microscope to photographic illustrations of various medical treatments, together with a number of pathological specimens which probably occupy the greater part of the exhibition.

The electron-microscope examination of certain metal surfaces at magnifications up to 25,000 times provides some very good examples of how many of the difficulties of this technique have been overcome. The classification of two different subjects under the same general title of "Autoradiography" provides the spectator with a moment of doubt as to which is more worthy of the title. The subject-matter of the first deals with the use of radioactive nickel in the preparation of an aluminium–nickel alloy: an autoradiograph was prepared by pressing the surface of the alloy into contact with a photographic plate to give a result showing the nickel-rich regions with much greater clarity than a corresponding radiograph of the same object. The second example consists of a radiograph of a high-voltage rectifier valve using a lead-lined pinhole camera, the film remaining in a light-tight paper sheath. The bombardment of the glass walls of the valve produced enough X-ray radiation to expose the film, which thus revealed the tracks taken by the secondary electrons. The use of X-rays is also shown in the critical examination of stamps, the picture of a used stamp being capable of complete separation from its postmark in certain circumstances. Nuclear fission is represented by a very impressive set of enlargements, one of which shows forty-two separate tracks produced by the collision of a single high-energy calcium nucleus with a silver or bromine nucleus in the emulsion. The greatly reduced distortion claimed for a new design of lens in an air-survey camera is demonstrated by means of photographs and curves. An example of analysis by Schlieren photography of the air flow and sound waves produced by an aerofoil in a stream of air travelling at about 900 ft. per sec. is also shown.

Under the group of medical exhibits is one of particular interest to microscopists. It illustrates the amount of distortion introduced by the cutting of a section of animal tissue embedded in paraffin wax. The section is compressed by the shearing action of the blade in a direction parallel to its movement, and a pair of sections of the same object cut at right angles to each other together with the original give a comparison of the distortion introduced. Among the remainder of the medical photographs are certain specimens, such as one showing rheumatic endocarditis, which has an almost third-dimensional realism and gives credit to the excellence of the photography, despite the grim nature of the subject. It is almost a relief to the non-medical observer to come across the rather beautiful results that have been achieved by the photography of a group of crystals of sodium biurate. A group of stereo-photomicrographs which comprises a study of the surfaces of paper and lithographic plates reveals a number of features that would be most difficult to visualize if presented as normal photographs.

There are also more than four hundred entries in the section on Nature photography, the majority being of birds and plants. A number were well illustrated by lantern and colour slides in addition to monochrome prints. A Society medal was awarded to Gordon F. Woods in this section for his fine contributions on the life-histories of the *Ailanthus* silk moth, the gipsy moth and the early thorn.

BRITISH WATER-COLOURS AT THE ROYAL ACADEMY

THE exhibition of the J. Leslie Wright collection of British water-colours at the Royal Academy is an event of outstanding importance. Amateurs of this peculiarly English form of art have known for years that Mr. Wright was building up at his home in Warwick a careful selection of paintings and drawings of the best period, and a privileged few have been able to inspect it from time to time. Now Sir Alfred Munnings, president of the Royal Academy, has prevailed upon Mr. Wright to show his collection in London for a month—the exhibition closes on November 6—to the great benefit of all who see it.

Although some are earlier and some are later, the collection, for all practical purposes, illustrates the period between 1750 and 1850. It begins with water-colour drawings, which are primarily drawings tinted with water-colour, and ends with water-colour paintings, in which the colour comes first and the drawing, though no less important, is not emphasized by 'lining in'.

Herein lies the particular interest of the collection; it takes us from the drawings of such masters as Rowlandson to the paintings of Girtin and Turner—to whom, more than any other two men, the change must be credited—but avoids that disastrous later period when it was the fashion so to misuse water-colour that the paintings looked as though they had been executed in oils.

There are fine series of works by Rowlandson, Gainsborough, de Wint, Paul Sandby, Cotman, Girtin and Turner, as well as shorter series by J. R.

Cozens, Bonnington, Francis Wheatley, and many others who, although not so widely known, were none the less masters of their craft.

Some of the pictures have an adventitious interest in addition to their artistic merits. For example, the Sandby gouache described in the catalogue as "Castle with Figures and Horses in the Foreground" is one of a number painted at Windsor, and another version is in the Royal Library there; it represents the Winchester Tower and the Hundred Steps. Incidentally, Sandby used powder colours mixed with isinglass and hastened the drying of his pigments by thinning them with gin, a practice not unknown to later generations.

In much the same sort of way, three of the Gainsborough drawings are interesting because they have been varnished. This was then the common practice when sketches in chalk or charcoal were intended to be used for teaching purposes. It destroyed so much of the texture and charm of the medium that such pictures are rarely seen in public exhibitions.

An artistic point to notice is the astonishing modernity of treatment displayed by many of the paintings. This is particularly well seen in "A View of Cayne Waterfall, near Dolgelly, North Wales" by Girtin. The rendering of the water reminds one so strongly of "A Waterfall" by J. D. Innes that one is tempted to speculate whether the latter could have seen the old master's work at some time. Finally, if anyone should imagine that a full palette is necessary for water-colour painting, let him, or her, ponder long and carefully over two or three of the Turners executed solely with blue, yellow ochre and Venetian red, and, perhaps, a touch of Chinese white. Not all the colours of the rainbow could convey the artist's message more clearly or more vividly.

A. T. Hopwood

CONFERENCE ON FOUNDRY STEEL MELTING

On September 22 and 23, the Steel Castings Division of the British Iron and Steel Research Association held, at Ashorne Hill, near Leamington Spa, a conference devoted to a consideration of recent scientific developments in melting steel in a manner and of a quality suitable for making into steel castings.

In early historical times, metals were used in the form or shape in which they happen to have been cast; later, metals were cast to the shape desired, so that the founder of metals is bound to look upon the operation of melting metals as subsidiary to the more intricate operation of casting to the desired shape. Although to-day the bulk of steel is made in furnaces of large capacity, and is cast in cast-iron moulds to form ingots of relatively simple geometric shapes which are afterwards mechanically worked into the shape or section required, there remains a very important section of metallurgical industry, the foundry industry, in which the demand for molten metal is determined by the founder and the rate of his supply of suitable moulds in which the metal can be cast. In a few large steel-works in Great Britain, steel is melted and is cast either into ingots or castings in accordance with the needs for either; but this is the exception rather than the rule, and in the majority of steel foundries the demand is for smaller quantities of steel at frequent intervals at a somewhat higher temperature than is required for ingot production. Thus the general problem of supplying liquid steel for a foundry differs in certain distinct ways from that of supplying bulk steel for ingot manufacture, and it was the object of this conference to discuss these differences with the view of guiding steel founders in the choice of the several types of steel-melting furnaces available to them. In actual fact the conference went much further than this, for not only did it provide a scientific exposition of the essential characteristics of present-day furnaces, but also, having dealt with certain developments being sponsored by the British Iron and Steel Research Association, it went on to indicate likely trends in the future.

The conference was arranged in four sessions held during the two days. The chairman for the first day was Mr. Richard Lamb, well known and highly esteemed in the industry, and chairman also of the Melting Sub-Committee under the guidance of which the conference had been arranged. Mr. Lamb was unable to be present on the second day, so that the chair was then taken over by Mr. H. Everard, a member of the same Sub-Committee and one who has been most active in the promotion of research in the important steel foundry with which he is connected. Fourteen papers were presented, eight of which were from men prominently associated with particular steel foundries and who were thus able to present first-hand practical experience of their own steel-melting furnaces. The other six papers were presented by men who fulfil the role of scientific advisers to the industry, and they included three members of the staff of the Association and three representing auxiliary industries.

The papers were not intended to be complete in themselves, but rather as introductions to the various phases of the subject, and were presented in such a manner as to encourage discussion, and so promote the dissemination of scientific information among those who are in a position to advance the standards of industrial achievement. The Association strongly supports the view that there is a great need for closer liaison between scientific workers and industry, and this is one of the reasons why such conferences as this are sponsored. In harmony with this idea, one of the most stimulating papers presented was by Mr. F. A. Martin, chairman of the British Steel Founders' Association and leader of the first 'productivity team' to visit America, who made a challenging comparison of British and American productivity and the underlying causes for the differences. Naturally there was some criticism of American methods, but it was evident that all present accepted the rebuke that British industry had been slow to apply within itself scientific developments, which in many instances were made by British scientific men. The need for greater industrial enterprise and confidence in its own scientific workers was stressed, as also was the need on the part of men of science to expound their findings in a form of language more easily apprehensible to the community at large.

It was assumed that all existing furnaces of whatever type and throughout the world justify their use in the particular circumstances in which they are employed, or that there is no single type of furnace which has all the merit; and that whether the present distribution of the various types of furnace continues in the future depends upon scientific developments, which it was the object of the conference to study. For this reason the first two sessions commenced with a brief survey of the two principal types of melting

process in use in Great Britain, namely, the cupola/converter and the electric arc processes respectively; while the third session dealt with other and less important processes, and the fourth session with the properties and cost of steel made by the various processes. Since a comparison of the processes was desired, discussion at each session was not limited to the particular papers presented at that session, and throughout there was lively discussion which probably constituted the major value of the conference. It is for this reason that the printed proceedings of the conference will include all the discussion—or at least as much of it as the contributors desire to be printed.

The first introductory paper on the cupola/converter process was prepared by Mr. F. Cousans, and it was followed by one on the design of converter by Mr. A. G. Robiette. The discussion on these two papers included a reference by Mr. M. P. Newby, of the Association's staff, to the work in hand in the laboratory with small-scale 'Perspex' models of converters in order to simulate furnace conditions and to provide a means of varying them experimentally. This drew one caustic comment typical of the response of mature experience to youthful and enthusiastic scientific experimentation, but none present questioned the potential value of such laboratory studies. The remark illustrated, however, how great is the gap between industrial knowledge or experience and that of the academic or scientific variety. Mr. A. J. Langner, of the staff of the Association, then explained the work in hand to de-sulphurize and de-phosphorize the metal more effectively, a matter for which there is great need and which thermodynamically is possible; and this was followed by an exposition by Dr. W. C. Newell of the principles and practice of oxygen enrichment applied to steel-making. This subject aroused much interest throughout the conference, and there is no doubt that it is one of those developments which could radically alter present-day steel-making practice. It also illustrates the value of co-operative research in pooling resources for the purpose of gaining scientific information from works' plant. Very often economic factors can deter industrial development, but these factors are notoriously changeable or at least capable of great change, and what was impracticable yesterday may become possible to-day and really attractive to-morrow. At the least, the scientific foundations are now laid for the application of oxygen enrichment to industrial steel-making, and already attractive economic, as well as technical, features are being demonstrated.

The second session opened with a paper by Mr. J. H. Pearce and Mr. W. Bramhall, in which the essential features about the operation of electric furnaces for foundries were explained; and this was followed by an account by Dr. J. R. Rait of the refractory lining of such furnaces. The discussion which followed revealed how much operating conditions influence refractory wear, and the practical steps which can be taken to reduce slag attack. It is probably not realized by those outside the steel industry how severe are the conditions of temperature and chemical activity in a steel-melting furnace, and this discussion showed how great is the problem of providing adequately resistant refractory lining to such a furnace. Mr. J. C. Howard then gave a paper on the electrical characteristics, output and design of electric arc furnaces, with the object of aiding a proper choice and technical control of these furnaces; and Mr. J. Mowat followed with an account of open-hearth furnace operation for foundry use. In a very frank way Mr. Mowat stated that he would not recommend the installation of such furnaces for foundries, but where they already exist for other steel requirements they are effective in also supplying foundry demands. Mr. F. A. Martin's paper on productivity, already referred to, then stirred up the conference to continue informal discussion upon the subject throughout the remaining evening. It is undoubtedly one of the advantages of holding such conferences in the agreeable surroundings of Ashorne Hill that informal discussion in the evenings is made so easy.

On the following morning, Mr. A. C. Brearley gave a lively and enthusiastic account of developments in German and American foundries during the past decade, reinforcing the emphasis already laid by Mr. Martin on the American method of operation of acid electric arc furnaces. Mr. C. McNair spoke about the operation of high-frequency furnaces, and Mr. Howard explained the type of equipment involved and its manner of operation, a strong case being put forward for this type of furnace as a simple melting unit for relatively small quantities. In discussion, the authors were pressed about the possibility of refining steel in such furnaces, but little hope was raised for this prospect. It was admitted that the stirring action taking place in these furnaces might have the tendency to maintain inclusions in suspension, but that with due care in subsequent de-oxidation very clean steel is obtained, that is, sulphide and oxide inclusions are not excessive.

In the final session, Mr. J. E. Worthington, of the staff of the Association, gave a description of the work in hand upon the fluidity of steel, by which is meant the ability of steel to flow and completely and accurately follow the contour of a mould. A new laboratory technique has been developed, and with it the correlation of fluidity with temperature and a wide range of compositions has been explored. The effect of temperature and alloy content is now accurately known, and there remains the problem of studying the more subtle differences in fluidity associated with different types of furnace. The conference concluded with a paper by Mr. F. N. Lloyd on economic aspects of melting steel in foundries, a subject which had frequently been raised in discussion earlier in the conference.

The success of the conference may be judged by the attendance of 110 persons, about half of whom were from steel foundries, and from the keen discussion which they gave to the papers, both in the conference hall and informally on all other possible occasions. The scientific staff of the Association were inspired in their work by the personal contacts which they made with their industrial colleagues, who were in turn encouraged by the demonstration of the valuable research being performed on their behalf, so that the ultimate consequences may be far-reaching. The urge for greater technical efficiency and productivity was strongly implanted or strengthened, and American operation of acid electric furnaces was held up as a shining example, which it is to be hoped may assist steel founders in Britain. As was made clear, conditions in the United States differ from those in Britain in many ways, not the least being in the mental outlook of the peoples; but it is hoped that the conference did to some extent inspire all present to a fuller and more rapid application of available scientific knowledge.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Mechanism of the Action of Urethane in the Treatment of Malignant Growth

ACCORDING to Haddow and Sexton[1], the inhibitory effect of urethane on cell proliferation in leukæmia and other malignant growth processes cannot be explained by the influence of the urethane on cell respiration, as the inhibition of the latter is only observed at much higher concentrations of urethane than can ever occur in the tissue of patients treated with urethane. Nevertheless we believe that the effect of urethane on malignant cell proliferation can be explained by its effect on the respiratory enzyme system.

Adenosine triphosphate must be regarded as the link between the energy-producing breakdown processes in the cell and the energy-requiring process of synthesis of cell material necessary for maintenance and growth. If the adenosine triphosphate produced is utilized at a faster rate as a consequence of increased synthesis of cell material, the energy-producing breakdown reactions will be speeded up, and conversely. In malignant growth, for example, leukæmia, so much adenosine triphosphate will be required that the enzymatic system involved in its production will be completely occupied. In other words, this enzymatic system will be the limiting factor in cell proliferation. In the relatively slow normal reproduction of white and red blood cells, however, the enzyme systems responsible for energy production will be working much below their maximal capacity. Hence, if a therapeutic dose of urethane is administered to a leukæmia patient, the partial blocking of the respiratory enzyme system in the cells will leave sufficient capacity for normal growth and maintenance, but not so for malignant cell proliferation.

We believe that this explanation applies to the effect of urethane on malignant growth in general and also to the application of arsenite in similar cases, and even to the bacteriostatic action of drugs with inhibitory action on respiration or other energy-producing processes.

The following model experiment corroborates this theory. Evidence obtained in this Laboratory shows that blood cells are capable of synthesizing aneurin pyrophosphate from added aneurin[2]. More aneurin pyrophosphate is formed from large than from small amounts of aneurin added. The energy necessary for the synthesis is derived from glycolysis and respiration. In this connexion it is unimportant that the ratios of the amounts of energy contributed by the two processes differ in red and white cells; but we may be sure that with larger amounts of aneurin added a higher demand will be made on the energy-producing systems than with smaller amounts, just as in the case of malignant growth as compared with normal.

Therefore, we added to samples of rat blood 1 γ or 1,000 γ of aneurin per ml. of blood and various amounts of urethane as indicated in the accompanying table. These samples were incubated at 39° C. for six hours. The figures show that with 1 γ of aneurin added the influence of urethane in the concentrations used is negligible.

Influence of urethane on synthesis of aneurin pyrophosphate from added aneurin by blood, expressed as a percentage of synthesis in the absence of urethane (increase: +; decrease: −)

Molarity of urethane	1 γ aneurin per ml.	1 mgm. aneurin per ml.
0·01	n.s.*	n.s.
0·03	—	+12
0·06	n.s.	+19
0·12	n.s.	n.s.
0·24	n.s.	−60

* n.s. = not significant

With 1,000 γ of aneurin added small amounts of urethane activate synthesis, while with the highest amount of urethane an inhibitory effect of not less than 60 per cent was observed. The nature of this activation is not as yet understood, but there are obviously two opposing effects due to urethane, which are in balance at about 0·12 mol. urethane. The activation can only be observed when so small a part of the enzymatic breakdown system is blocked that the breakdown system still has sufficient capacity to meet the energy requirement of aneurin pyrophosphate synthesis.

Similar phenomena are observed in the treatment of leukæmia patients with urethane: (1) with small amounts of urethane, both the erythropoietic and the leucopoietic systems are activated; (2) in the first days of treatment with larger doses of urethane, when obviously urethane has not yet accumulated in sufficient amount to effect inhibition, the leucopoietic system is activated; (3) when the leucopoietic system is inhibited the erythropoietic system, with lower energy requirement for synthesis, can be activated.

We wish to thank Prof. H. G. K. Westenbrink and Prof. C. D. de Langen for their helpful criticism and advice on this subject.

E. FLORIJN
G. SMITS

Laboratory of Physiological Chemistry,
and Medical Clinic,
University, Utrecht.
April 28.

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Inhibitory Effect of Thyroxine Analogues on Oxygen Consumption in Mice

WE have studied the effect of a number of analogues of thyroxine on oxygen consumption in mice by a method to be published in detail elsewhere. In these experiments sixteen mice, divided into two groups of eight, were used as controls, and similar groups were treated with thyroxine or thyroxine plus analogue by subcutaneous injection. Although no compound so far examined has produced a decisive fall in mouse metabolism when given alone, a substantial inhibition of the effect of thyroxine on oxygen consumption was obtained with the two compounds shown in the table.

These results indicate that the antithyroxine effect of 3 : 5-diiodo-4-benzyloxybenzoic acid in tadpoles reported by Frieden and Winzler[1] is also observed in mice, although a much higher ratio of inhibitor to thyroxine is required. In our experiments the new compound, 3 : 5-diiodoanisaldehyde dimethylacetal, was slightly more effective. This compound was prepared as described by Wilkinson[2]. We are indebted

Compound	3 : 5-Diiodoanisaldehyde dimethylacetal		3 : 5-Diiodo-4-benzyloxybenzoic acid	
Dosage (mgm./kgm.)				
Compound	500	200 × 3	500	200 × 3
Sodium thyroxine	1·0	1·0	0·5	0·5
Molar ratio (Inhibitor/thyroxine)	900	1,100	1,650	2,000
Oxygen consumption (ml./gm./hr.) Mean ± S.E.				
Controls	100	100	100	100
Thyroxine	193 ± 7·75	179 ± 4·1	180 ± 7	179 ± 4·1
Thyroxine plus inhibitor	138 ± 6·7	118 ± 3·2	143 ± 12·5	126 ± 4·08
Percentage inhibition	55	61	37	53
Significance of results by Fisher's *t* test	$P = 0·01–0·001$	$P = < 0·001$	$P = 0·05–0·02$	$P = < 0·001$

to the Research Division of Glaxo Laboratories, Ltd., for supplies of 3 : 5-diiodo-4-benzyloxybenzoic acid, which was prepared by the method of Frieden and Winzler[1].

N. F. Maclagan
M. M. Sheahan
J. H. Wilkinson

Department of Chemical Pathology,
Westminster Medical School,
London, S.W.1.
Sept. 8.

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Competitive Inhibition by Histamine and Thiamine of the Metabolic Influence of Antihistamines on Bacteria

In experiments on the influence of antihistamines on the decarboxylation of histidine[1], we isolated bacterial strains of *Esch. coli* (778), *A. aerogenes* (688), *Ps. aeruginosa* (607), which possess histidine decarboxylase, and which use histidine as their only source of carbon.

In these experiments we started from the following facts ascertained earlier[1]: (1) The antihistamines have a bacteriostatic influence demonstrated to be a metabolic inhibition; the growth of strain 607 cultivated in a synthetic medium was inhibited by antihistamines to a concentration of 1 : 5,000. In broth, where the same strain could form pyocyanine (accessory respiratory ferment) this metabolic influence of the antihistamines was eliminated up to a dilution 1 : 200, although in the other strains there was no difference in the inhibition compared with the synthetic medium. (2) We also observed that histamine, as a pure chemical substance, is not utilized by strains 778 and 688; on the other hand, strain 607 could utilize histamine as its only source of carbon.

On the basis of these observations, we believe we have been able to carry out a decisive experiment on the question of the action of antihistamines and histamine on bacterial metabolism. To a medium in which glucose was the only source of carbon, antihistamines Spofa III 101 (piperidylethyl-benzhydryl-ether) and Neoantergan were added in concentrations of 1 : 5,000, 2,500, 1,000, that is, within the limits from inhibition to complete stoppage of the growth of bacteria. For each dilution of the antihistamines, histamine and thiamine from 1 : 100 to 1 : 50,000 were added and the growth followed on a Hilger Biochem absorption meter. At the same time a similar medium was inoculated with glucose without antihistamines, and histamine and thiamine were added in the same dilutions as to the media with antihistamines. Finally, a medium was prepared in which histidine was the only source of carbon; antihistamines, histamine and thiamine were added in the same way as to the medium with glucose.

The results obtained can be summarized as follows:

(1) Though the strains 778 and 688 are inert to histamine, there appears in the medium with glucose and histamine as well as in the medium with glucose and thiamine a considerable growth effect compared with the control (Figs. 1 and 2).

(2) In the medium with glucose and antihistamines, the effect of antihistamines on bacteria was excluded by histamine and thiamine. As can be seen from Figs. 1 and 2, their effect against antihistamines runs parallel to the growth effect.

(3) In the medium in which the only source of carbon was not glucose but histidine, we did not observe any inhibition of the bacteriostatic effect by histamine. This fact agrees with the results obtained in decarboxylation[1], where no inhibition of the effect of the antihistamines was found, though histamine was ascertained to be present in the medium with histidine.

These results indicate that the antihistamines have a polyvalent metabolic influence in blocking the enzymatic groups of bacteria; the blocking effect of these substances occurs not only in synthetic glucose medium but also in various media containing other sources of carbon (broth, medium with histidine). This blocking effect, tested as bacteriostasis, can be suppressed by adding histamine or thiamine. It seems that this interaction, between antihistamines on one hand and histamine and thiamine on the other, can be explained as a competitive inhibition: (*a*) histamine and thiamine are growth factors for the bacteria used in the glucose medium; (*b*) an inhibitory

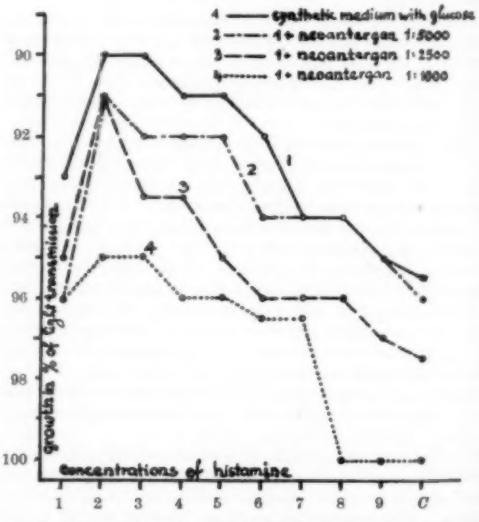

Fig. 1. The growth of the strain 688 after 10 hr. culture in various concentrations of histamine: (1) 1 : 100; (2) 1 : 500; (3) 1 : 1,000; (4) 1 : 2,500; (5) 1 : 5,000; (6) 1 : 7,500; (7) 1 : 10,000; (8) 1 : 25,000; (9) 1 : 50,000; *C*) without histamine

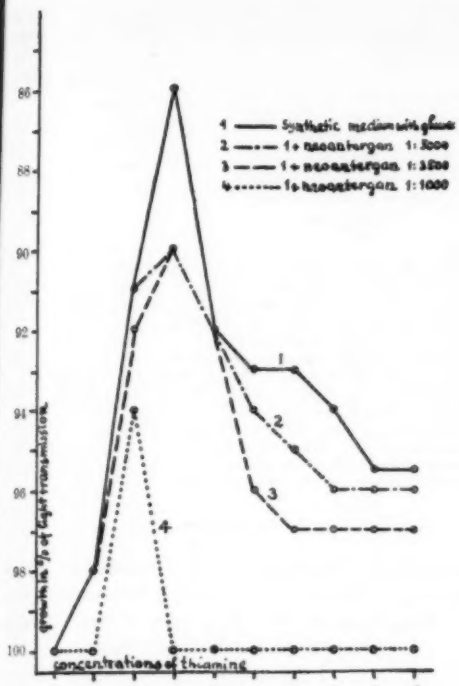
1 —— Synthetic medium with glucose
2 —·— 1+ neoarsergan 1:3000
3 —·— 1+ neoarsergan 1:2000
4 ····· 1+ neoarsergan 1:1000
growth in % of light transmission
concentrations of thiamine
1 2 3 4 5 6 7 8 9 C

Fig. 2. Growth of strain 688 after 10 hr. culture in various concentrations of thiamine. Concentrations as in Fig. 1

effect of thiamine and histamine on the blocking effect of antihistamines on bacterial growth occurs only when bacteria utilize glucose as source of energy; histamine and thiamine growth-promoting effects on bacteria have a similar quantitative relation to the suppressing effect of these substances on the bacteriostatic action of antihistamines.

Histamine acts in a similar way to thiamine in our bacterial strains, possibly as a coenzyme in the catabolism of glucose.

J. Šterzl

Institute for Medical Microbiology,
Charles University,
Praha II.

J. Křeček

Institute for Control and Research,
United Pharmaceutical Works,
Prague.
May 13.

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Influence of Histamine on Nerve Block due to Anti-Histaminics

Most of the anti-histaminic drugs are local anæsthetics[1]. Procaine, too, has an anti-histaminic action[2]. Euler has demonstrated the presence of large amounts of histamine in certain nerves[3]. We have investigated the influence of histamine on the nerve block caused by procaine and some of the anti-histaminics. In the frog nerve–muscle preparation, we have found that a nerve block caused by, for example, pyribenzamine can be removed by washing with a solution containing, besides the blocking concentration of the local anæsthetic, a certain concentration of histamine. If the nerve is placed in contact with the mixture of histamine and blocking agent solution, no block results even when the concentration of the blocking agent is quite sufficient for producing block if applied alone. Two typical experiments follow.

(1) *Removal of block.* The sheath of a nerve was removed for a stretch of about 7 mm., and a solution of 0·25 per cent pyribenzamine in frog's Ringer solution was applied. Conduction was tested with short bursts of stimuli at 50 per sec. from a thyratron device. The nerve was blocked after 4 min. The block was removed in 3 min. by washing with frog's Ringer solution to which had been added 0·25 per cent pyribenzamine and 0·6 per cent histamine-dihydrochloride.

(2) *Prevention of block.* Two nerve–muscle preparations from the same frog were used. The sheaths of the nerve were left intact. Nerve *A* was placed in 0·3 per cent procaine hydrochloride in frog's Ringer solution; nerve *B* in 0·3 per cent procaine hydrochloride + 0·4 per cent histamine-dihydrochloride in frog's Ringer solution. Nerve *A* was blocked after 18 min., whereas nerve *B* was still conducting after 100 min.

This investigation is being continued.

Ernst Bárány
Percy Nordqvist

Pharmacological Institute,
University, Uppsala.
May 14.

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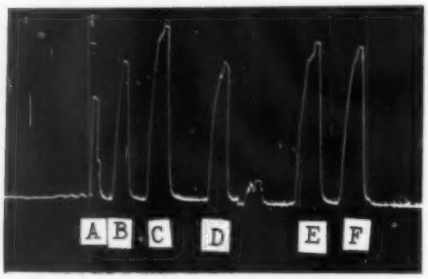
Presence of a Spasmogenic Substance, presumably Histamine, in Extracts of Mummy Tissue

Egyptian mummies as well as mummified bodies from other parts of the world have been the subject of extensive investigation. Thus, for example, it has been possible to obtain blood-group reactions with mummified tissue, as shown by Boyd and Boyd[1], Candela[2] and Matson[3]. In the field of palæopathology, a term created by Ruffer[4], the microscope has revealed the persistence of many characteristic cells and other histological features in sections of mummies and similarly treated bodies. In a recent investigation[5], I have even demonstrated, among other matters, the existence of red blood corpuscle remnants in ancient Swedish skeletons (Viking age), buried without the embalming procedures used in Egypt and elsewhere. Pictures of relatively well-preserved organic framework of bone tissue were obtained with material even from so early a period as the Upper Stone Age.

Various substances have been identified in mummified tissues by means of chemical methods. Schmidt[6] studied the occurrence of products of fat cleavage, and Abderhalden and Brahm[7], Abderhalden and Weil[8] reported observations on amino-acids. Several amino-acids were demonstrated after acid hydrolysis of mummy muscles, including histidine and considerable amounts of tyrosine.

It was now thought possible to ascertain, using the method of Code[9] as modified from Barsoum and Gaddum[10], whether histamine occurs in measurable amounts in mummy tissue and other ancient human remains. Soft tissue (skin from the neck) and bone (cervical vertebra) from a mummy of the Egyptian Museum in Stockholm and supposed to be about three thousand years old were ground to a fine powder. This was treated by the method devised by Code.

A definite spasmogenic activity was found in the extract thus prepared (see diagram). The spasm of the isolated guinea pig's small intestine elicited with the extract could be prevented with an antihistamine drug and was to a certain degree counteracted by atropine. The doses of antihistamine (dimethylaminoethylbenzylaniline) and atropine were those used by Schmiterlöw[11].



A, 0·25 γ histamine added to bath. *B*, 0·30 γ histamine added to bath. *C*, 0·35 γ histamine added to bath. *D*, 0·10 γ acetylcholine added to bath. *E*, 0·50 ml. extract of mummy skin, corresponding to 0·025 gm. dry weight of tissue. *F*, 0·50 ml. extract of mummy skin; the same contraction height as in *E*. In this assay the histamine equivalent of the tissue was 12·8 γ/gm.

Several extractions and assays were made. As mean values histamine equivalents of 10–40 γ histamine hydrochloride per gm. mummy skin and 2 γ per gm. mummy bone were obtained. No data were found in the literature concerning the histamine content of bony tissue; the mummy bone specimen I used was, however, free neither from periosteal connective tissue nor from bone marrow remnants. Corresponding extracts of ground ancient bones found in Swedish soil (Stone Age to Viking Age) showed no spasmogenic activity.

The figure for the histamine content of the mummy's skin is somewhat lower than the values reported by Nilzén[12], who examined thirty-three healthy subjects and found histamine values of the skin (calculated per dry weight) ranging between 16 and 83 γ per gm., with 37·7 γ per gm. (expressed as base, which corresponds to 62·9 γ hydrochloride) as a mean value.

In order to prove the identity of the histamine demonstrated in the intestine bath, the extract was injected intracutaneously into human skin. A faint but clearly visible 'triple response' was observed. The histamine concentration in the injected extract corresponded with that calculated from the guinea pig assay, namely, $0{\cdot}2 \times 10^{-5}$, which is just on the limit for giving a wheal reaction. Furthermore, the extract was examined by Pauly's[13] reaction and compared with a fresh standard histamine solution, containing 2 γ per c.c. The colour developed was exactly the same. The light absorption curves showed a parallel course, with only slight differences in the intensity of absorption.

It therefore seems fairly reasonable to suppose that the substance present in the extract was really histamine.

WILHELM GRAF

Department of Histology,
Karolinska Institutet,
Stockholm.
Histamine Laboratory,
Dermatological Clinic,
Karolinska Sjukhuset,
Stockholm.
May 2.

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Adenosine Triphosphatase Activity: Spontaneous Dissociation and Recombination of Actomyosin in Extracts from Cross-Striated and Uterine Muscle

IN previous papers[1], a difference has been reported between the actomyosin concentration of the uterine and the cross-striated muscle in favour of the latter. Furthermore, differences in the actomyosin concentration of the uterine muscle due to species specificity and an increase in actomyosin concentration with advancing pregnancy have been demonstrated. In this work, the actomyosin concentration was determined by the viscosimetric method described by Szent-Györgyi[2], and Straub[3]. The use of the viscosimetric technique, however, offers some further possibilities. Mommaerts[4] has followed the whole course of the actomyosin–adenosine triphosphatase reactions of cross-striated muscle in the viscosimeter, and he divided the curve showing the characteristic viscosity changes into two parts: 'viscosity response' (initial drop) and 'recovery-effect' (rising phase). In his interpretation, the 'recovery effect' shows the course of the enzymatic hydrolysis of the adenosine triphosphate by the myosin.

While studying the viscosity changes of actomyosin solutions, it has been found that during the reactions:

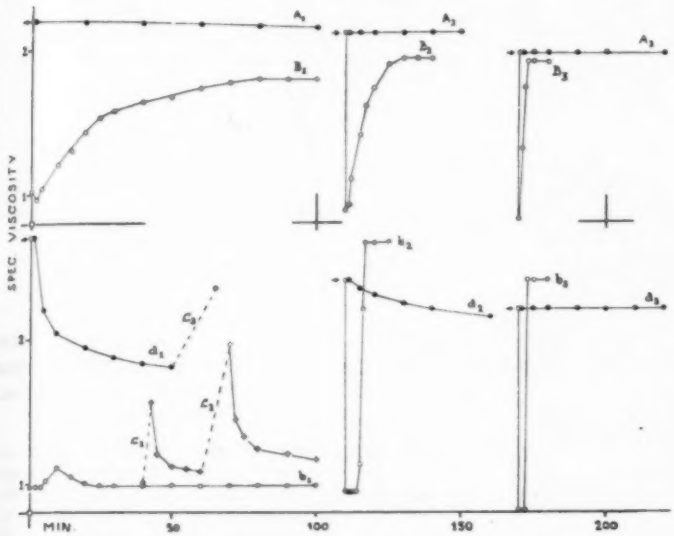
$$AM + ATP \rightarrow A + M + ATP \rightarrow AM + \text{hydrolysed } ATP,$$

the U-shaped curve obtained indicates three different reactions. It has been shown that when the viscosity begins to rise, there is no longer any detectable adenosine triphosphatase left in the reaction mixture, even when tested by a sensitive method (limiting amount, 5 μgm.).

The enzymatically active phase is indicated by the horizontal part of the U-curve. It is possible to determine this 'splitting-time', and this technique enables us to determine the adenosine triphosphatase activity and concentration of adenosine triphosphatase of different solutions.

The rising phase of the U-curve shows the course of the recombination, and starts only after the adenosine triphosphatase has been split. This phase depends on temperature.

A comparative study was carried out on solutions of actomyosin prepared from cross-striated and uterine muscle. Characteristic differences were found between the two types of extracts, as can be seen in the U-curves reproduced herewith.



Upper curves: Rabbit uterus taken 3 hr. post partum (undiluted extract). Lower curves: Rabbit cross-striated muscle myosin *B* (dilution 1 : 4). Spontaneous dissociation: at 0° C., $A_1 - a_1$; at 20° C., $A_2 - a_2$; at 37° C., $A_3 - a_3$. Recombination: at 0° C., $B_1 - b_1$; at 20° C., $B_2 - b_2$; at 37° C., $B_3 - b_3$. Immersion in 37° C.: C_1, 3 min.; C_2, 10 min.; C_3, 15 min. → addition of 1 mgm. adenosine triphosphatase (potassium salt)

The spontaneous dissociation of actomyosin from both types of muscle seems to depend on temperature (curves A_1, A_2, A_3—a_1, a_2, a_3). The reaction $AM \rightarrow A + M$ at 0° C. may be complete in the case of actomyosin from cross-striated muscle, but recombination occurs ($A + M \rightarrow AM$) when the viscosimeter is placed for a few minutes in a water-bath at 37° C. (curves C_1, C_2, C_3). In contrast with actomyosin from uterine muscle (curve B_1), no recombination occurs after splitting of adenosine triphosphatase in the case of actomyosin from cross-striated muscle (curve b_1) at 0° C. The recombination after spontaneous dissociation or after splitting of adenosine triphosphatase depends on temperature and reaches its maximum value about 20° C.

The recombination of the uterine actomyosin takes place much more slowly than that from cross-striated muscle.

A full report of this work will be published in the *Acta Physiol. Scand.*

A. Csapó

Department of Pharmacology,
University of Uppsala.
Feb. 16.

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Study of the Pituitary Body with the Periodic Acid–Schiff Reaction

In 1942, we established[1] that cytoplasmic granules within the cyanophile cells of the human pituitary body possess metachromatic properties towards toluidin blue and give a positive Bauer reaction. We therefore concluded that these granules are of mucoprotein nature. We can relate this fact to the observations of Hartman and Benz[2] and of Evans, Fraenkel-Conrat, Simpson and Li[3] establishing that gonadotropic hormones and especially F.S.H. contain a proportion of polysaccharides and glucosamine and are, therefore, also allied to mucoproteins.

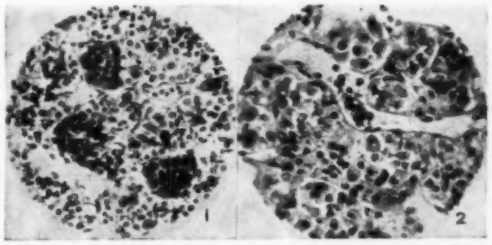
Since then, the use of periodic acid – Schiff reagent in the histochemistry of mucins and polysaccharides has been introduced by Hotchkiss[4] and McManus[5], and the latter author points out that some pituitary cells and the colloid of the pituitary stalk give a positive response by this technique. Recently, Pearse[6] has emphasized these findings and has observed that the granules of the cyanophile cells, in fact, give this reaction, confirming our own work. The same author found a positive reaction in the colloid and observed fine droplets positive to the reagent present in some chromophobes.

We have now applied the method to the study of the human pituitary body and have established the following facts:

(1) Cytoplasmic granules of the cyanophile cells give a violet colour, frequently slight, but nevertheless a positive reaction. However, this reaction increases with age, as well as the affinity of these granules for toluidin blue, and is especially weak in children.

(2) The colloid in the vesicles exhibits a very marked purple reaction. This method allows us to see between the cells numerous micro-vesicles otherwise difficult to observe. Furthermore, in some favourable cases, numerous droplets of colloid can often be be distinguished within the lumina of the sinusoids.

(3) Some cells, more or less numerous, contain fine droplets of a material strongly positive to the periodic acid – Schiff reagent; these droplets are much more purple than the granules with the cyanophile cells.



1. Group of cyanophile cells. 2. Colloid droplets within the lumen of a sinusoid

The droplets are more frequently found scattered within large chromophobes but also within eosinophiles, and even, although rarely, within some cyanophiles. These large chromophobes correspond to the γ- and ε-cells of Romeis[7], and this author has already observed these droplets, which he has described as intracellular colloid droplets. Indeed, we frequently observe these droplets falling into the colloid vesicles. This observation and the strongly positive reaction of these inclusions confirm Romeis's opinion.

The periodic acid – Schiff method confirms the mucoprotein nature of the cyanophile granules; it proves that these granules are quite different from the colloid droplets, the latter giving the reaction more strongly, and indicates the mechanism of colloid formation within the cells and its discharge into vesicles or into the lumina of the sinusoids.

MARC HERLANT

Laboratoire d'Anatomie Pathologique,
Université libre de Bruxelles. May 17.

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Sympathomimetic Substance in Human Lumbar Sympathetic Chain

IN 1939, Lissak[1] showed that extracts of sympathetic nerves contained a sympathomimetic substance with an adrenaline-like action on various biological preparations. In a series of papers, von Euler[2,3,4] has demonstrated that this type of extract is largely *nor*adrenaline. His chief sources of material were cattle and horses. Lissak[5] further showed that if a postganglionic sympathetic nerve was stimulated electrically, and the cut end of the nerve allowed to hang beneath the surface of acidified saline during the passage of the current, the saline assumed sympathomimetic properties from diffusion into it of an adrenaline-like substance from the nerve.

A series of five specimens of human lumbar sympathetic chain were obtained by courtesy of various surgical colleagues at the Cardiff Royal Infirmary, to whom thanks are due. The specimens were taken at once from the operating theatre wrapped in gauze moistened with saline. They were washed in saline, dried gently and suspended from electrodes. Four of the specimens consisted of lumbar sympathetic ganglia L_4 and L_5, with a length of chain between and a stump of chain beyond each ganglion. These specimens were suspended from the middle and threaded through holes in filter paper, which was caused to ring the surface of the nerve closely, just above the ganglia; this prevented anything dripping from the nerve surface to the fluid beneath. The cut ends dipped below the surface of 2·0 ml. of 0·65 per cent saline at *p*H 4 (hydrochloric acid). The fifth specimen included ganglion L_2, which was very close to L_4. It was suspended by L_2 and L_4 from the electrodes and the cut end distal to L_5 submerged. Stimulation was carried out for fifteen minutes from a coil at 12 cm. distance. The fluid was taken and a portion neutralized and 0·2 ml. administered at once to a frog's heart perfused by Hartung's method[6]. In all cases the fluid was sympathomimetic, that is, it produced a quickening and increase in force and amplitude of the beat of the heart. An equivalent effect was produced by *l*-adrenaline 0·01 μgm. or *l-nor*adrenaline 0·1 μgm. The fluid was stored at 4° C. and given intravenously to chloralosed cats with a high blood-pressure as soon as convenient, usually next day. 1·0 ml. of fluid given slowly produced a rise of blood pressure of about 15 mm. mercury, but little or no effect on the non-pregnant uterus. 0·05 μgm. of *l*-adrenaline (adrenaline equivalent of 1·0 ml. fluid from the frog-heart test) caused a fall in blood pressure and relaxation of the non-pregnant uterus; *l-nor*adrenaline 0·5 μgm. caused a rise in blood pressure and no effect on the uterus. Saline controls had no effect. All three substances inhibited the movements of isolated rabbit intestine.

It was concluded that post-ganglionic fibres of the human sympathetic chain secrete a sympathomimetic substance which more closely resembles *nor*adrenaline than adrenaline.

The specimens were dried, the ganglia cut from the fibres and the parts weighed. They were triturated with washed powdered glass and extracted with 1·0 ml./gm. wt. of acid saline (*p*H 3·0). The filtrate from this was dialysed through a collodion membrane in a centrifuge at medium speed for one hour, against an equal volume of acid saline. The latter fluid was then taken, neutralized and tested as before. Extract of sympathetic ganglia inhibited the frog heart, and frequently stimulated it after initial inhibition. Atropine abolished this inhibition. Extracts of ganglia also caused a fall in blood pressure in the cat, not entirely abolished but reduced by atropine, and variable effects on rabbit intestine. Extracts of sympathetic chain were sympathomimetic and gave mixed and confusing effects which suggested the presence of a mixture of adrenaline and *nor*adrenaline. After dihydroergotamine the effect on the blood pressure was reduced or largely annulled but not reversed. The administration of an antihistamine compound 2786 *RP* did not affect the results. The actions of extracts of sympathetic chain fibres resembled those of extract of phæochromocytoma, as described recently by Holton[7] and confirmed by Euler and Hamberg[8]. These authors confirmed the presence of a mixture of *nor*adrenaline and adrenaline by paper chromatography. The biological reactions they describe were similar to those found in acid extract of normal sympathetic chain or in acid extract of an adrenal tumour (supplied by courtesy of Prof. J. Gough, Pathology Department, Cardiff Royal Infirmary), in which it was estimated by biological assay that the medullary tumour substance contained 10·6 mgm./gm. of *l-nor*adrenaline and 2·7 mgm./gm. of *l*-adrenaline equivalents.

It is concluded that human sympathetic nerve chain contains an extractable sympathomimetic 'ergone' which may be a mixture of adrenaline and *nor*adrenaline.

JAS. D. P. GRAHAM

Department of Pharmacology,
Welsh National School of Medicine,
Cardiff. May 25.

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A General Method of Esterification using Trifluoracetic Anhydride

For the synthesis of esters from carboxylic acids and alcohols or phenols, it is customary to heat the reactants for several hours in the presence of a strong mineral acid catalyst, or else to proceed via the acid chloride or the acid anhydride. We now report a method of esterification which obviates the necessity of a two-stage process and, at the same time, enables a rapid direct reaction to occur between the acid and the hydroxy-compound under mild conditions. The new method, which entails the use of the anhydride of trifluoracetic acid, gives the purified esters in yields of 60–90 per cent.

The standard technique involves warming the carboxylic acid (1·5 moles) together with trifluoracetic anhydride (1·5 moles) for a few minutes before adding the alcohol or phenol (1 mole for a monohydroxy-compound and a proportionate amount for a polyhydroxy-compound) and then maintaining the mixture at 40–60° for about 15 min. The resulting solution may then be poured into aqueous sodium bicarbonate and the ester isolated in the usual manner. By this method glyceryl tripalmitate, *p*-nitrobenzyl acetate and ethylene dibenzoate have been made. Minor modifications can be introduced to suit the individual case; for example, acetylations of mannitol and of β-naphthol proceed spontaneously and, without the application of any external heat, are complete in about three minutes.

An advantage of the method is that solid reactants do not require the introduction of a solvent, for we have isolated, by the standard technique, good yields of *p*-nitrobenzyl phenylacetate, diphenyl adipate and the benzoates of phenol, β-naphthol, *p*-nitrobenzyl alcohol and mannitol.

The conditions of the reaction are sufficiently mild to enable it to be employed for the esterification of glycosides; for example, for the acetylation of α-methyl glucoside, trehalose and (with care) sucrose, and for the propionylation of α-methyl glucoside and maltose. It is worthy of note that cellulose, starch and other polysaccharides can be acetylated and benzoylated in 60 min. or less at 50° to give essentially fully esterified products.

The new method would appear to be advantageous for the self-esterification of hydroxy-acids to give polyesters. We have prepared one such polyester by treating *p*-hydroxy-benzoic acid with trifluoracetic anhydride at 75° for 15 min.

It is to be noted that two patents (B.P. 285,858 and 313,408) have described the use of monochloracetic anhydride as an 'impeller' for the esterification of cellulose with carboxylic acids; but in these cases a catalyst, namely, magnesium perchlorate or sulphuric acid, was also employed. We have obtained various examples of other uses for trifluoracetic anhydride as a condensing agent, and these will be described in a later communication. We are greatly indebted to Imperial Chemical Industries, Ltd., General Chemicals Division (Widnes), for supplies of trifluoracetic acid.

M. Stacey
E. J. Bourne
J. C. Tatlow
J. M. Tedder

A. E. Hills Laboratories,
University,
Birmingham 15.
May 11.

Metal Catalysis of Indole Production

The production of indole from tryptophan by the action of copper sulphate and 9 per cent (w/v) sodium hydroxide was reported by Herzfeld[1] and confirmed by Baker, Dawes and Happold[2] in an attempt to elucidate the mechanism of the tryptophanase enzyme system of *Esch. coli*[3]. Catalysis of indole production was shown to occur with copper and cobalt, but not with other metals (including iron, manganese, nickel, chromium, tin and cerium). This specific effect of copper and cobalt is detectable down to concentrations of 5×10^{-6} *M*, and both metals show approximately the same catalytic activity. Only indole formation was observed at that time.

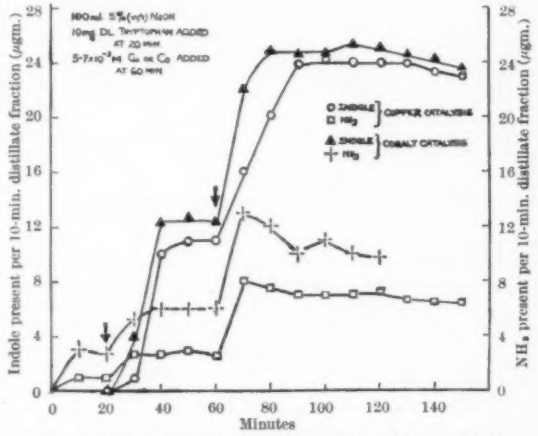

Fig. 1. Products of tryptophan decomposition with copper and cobalt catalysis

We now wish to record that the products of the reaction, other than indole, are ammonia and pyruvic acid (as with the enzyme-catalysed reaction[4]). Indole and ammonia production have been followed by determinations on successive fractions of distillate collected over 10-min. intervals, and pyruvate determined in the distillation flask residue. 100 ml. 5 per cent (w/v) sodium hydroxide was distilled and the volume kept constant by the addition of boiling distilled water. When the ammonia in the distillate had fallen to constant low level, 10 mgm. DL-tryptophan was added. Some indole was formed, due sometimes to trace metals present in the sodium hydroxide and always to trace metals resulting from the solvent action of the boiling alkali on the glass distillation vessel. The indole and ammonia distillation reach a constant level, and when this has occurred the appropriate salt is added to a concentration of 5×10^{-3} *M* and the distillation continued. This results in a very marked increase in indole and ammonia production (see Fig. 1). Ammonia production was invariably ahead of indole formation, which suggests that deamination occurs first, as found with certain enzyme preparations[5] (see table).

Substrate	Catalyst	Products per 10-minute distillate	
		Indole (μmol.)	NH_3 (μmol.)
Tryptophan	Cu	0·11	0·34
	Co	0·11	0·43
β-Indolyl-3-ethylamine	Cu	0·35	0·68
	Co	0·10	0·43

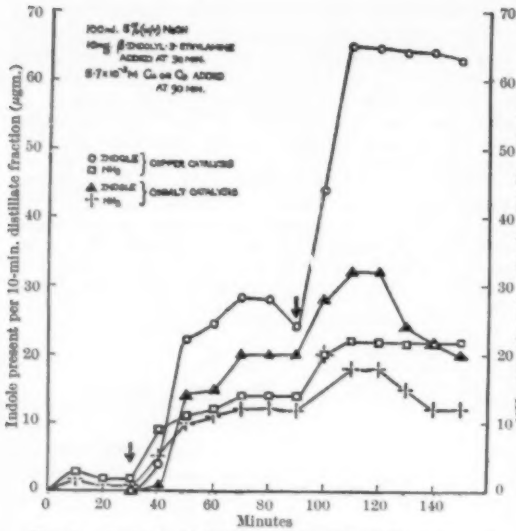

Fig. 2. Products of β-indolyl-3-ethylamine with copper and cobalt catalysis

The metal-catalysed reaction differs from the enzymic reaction since indole is also produced from β-indolyl-3-ethylamine and indolyl-3-glycine, which are not degraded by the enzyme. In the case of β-indolyl-3-ethylamine, an important difference occurs, copper being more than twice as effective as cobalt and also causing a much higher indole production than from the equivalent amount of tryptophan (Fig. 2). Acetylene or primary amines could not be detected in the distillate, indole and ammonia being the only products identified and determined. We have but a single observation for copper with indolyl-3-glycine, the behaviour of which was similar to that for tryptophan.

E. A. Dawes
F. C. Happold

Department of Biochemistry,
School of Medicine,
University of Leeds.
May 19

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Synthesis of β-*Iso*maltose Octa-acetate

Recently, crystalline derivatives of *iso*maltose, 6-α-D-glucopyranosyl-D-glucose, have been prepared by controlled hydrolysis of dextran and by application of the chromatographic techniques[1]. It is proposed to outline here a synthetic method of preparing *iso*-maltose derivatives.

Pacsu's[2] method of converting β-glycosides into the corresponding α-glycosides with the aid of titanium tetrachloride has, hitherto, been used only for alkyl glycosides. Studies of the velocity of such transformations showed that electron-attracting groups in the aglycon strongly retard this reaction. This is the reason why β-alkyl cellobiosides can be transformed into α-alkyl cellobiosides without any appreciable formation of maltose derivatives. In cellobiose there are two oxygen atoms in the α-position to the glycosidic oxygen, while in gentiobiose there is only one. It might, therefore, be possible to transform gentiobiose derivatives into the *iso*maltose series. This view is further supported by the fact that Pacsu[3], when he prepared gentiobiose chloride hepta-acetate from β-gentiobiose octa-acetate and titanium tetrachloride, obtained a product which had a higher specific rotation and a lower melting point than reported by other authors for that substance. Pacsu's value for the rotation is also not in agreement with that calculated by the application of Hudson's rules of *iso*-rotation. His substance probably contained considerable amounts of *iso*maltose chloride hepta-acetate.

β-*Iso*maltose octa-acetate was prepared in the following manner. α-Gentiobiose octa-acetate in absolute chloroform was boiled with a large excess of titanium tetrachloride. The resulting mixture of gentiobiose and *iso*maltose chloride hepta-acetate was treated with mercuric acetate in acetic acid. By this reaction the β-octa-acetates were obtained. When the mixture of these was recrystallized from methanol, β-gentiobiose octa-acetate separated. The residue was concentrated and, when seeded with β-*iso*maltose octa-acetate (kindly supplied by Prof. Wolfrom), a second yield of crude β-*iso*maltose octa-acetate was obtained. It was purified by two further recrystallizations (m.p. 143–144°, $[\alpha]_D^{20} + 98°$ in chloroform). It is identical with the β-*iso*maltose octa-acetate prepared by Wolfrom, Georges and Miller[1].

A detailed report will appear in *Acta Chemica Scandinavica*.

Bengt Lindberg

Institute of Organic Chemistry,
Royal Institute of Technology,
Stockholm.
May 9.

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Estimation of Epoxides

Epoxides occur among the products of the autoxidation of unsaturated fatty acids[1] and drying oils[2], and it has been suggested that they may be formed as intermediates in certain biological oxidations. Their accurate estimation is therefore a matter of considerable importance.

Oleic and elaidic acid oxides react smoothly and quantitatively with hydrogen chloride in dry ethereal solution to form chlorohydroxystearic acids, and can be estimated by this means[3]. This method was adapted by Swern *et al.*[4] to the determination of oxirane oxygen in general, and has been used to investigate the autoxidation products of methyl oleate and the drying oils[3]. For this purpose, a weighed amount of material is dissolved in an excess of a 0·1–0·25 *N* solution of hydrogen chloride in dry ether and the excess of hydrogen chloride determined at the end of three hours.

During work on the halogenohydroxystearic acids[3], it became clear that the absorption of hydrogen chloride by epoxides takes place equally well under conditions which are not strictly anhydrous, and from solvents other than ether; further, that the absorp-

tion is much more rapid than has generally been assumed. Quantitative results can readily be obtained, and the disadvantages attending the use of anhydrous ethereal hydrogen chloride avoided, by employing a reagent prepared by mixing 1–1·5 ml. of concentrated hydrochloric acid with 100 ml. of pure dioxan and leaving the reagent in contact with the epoxide for ten minutes only. Alcoholic hydrochloric acid can also be used, but some esterification is likely to occur if the material under investigation contains carboxylic acids. Dioxan is purified by leaving it in contact with solid potassium hydroxide for several days, followed by fractional distillation.

For an estimation, about 0·1 gm. of the epoxide-containing material is accurately weighed out in a stoppered weighing bottle of 50–60 ml. capacity, and 10 ml. of the dioxan–hydrochloric acid reagent is added. After 10 min., 10 ml of neutral ethanol containing five drops of 1 per cent alcoholic phenolphthalein is added, and the solution is titrated with decinormal sodium hydroxide until a faint pink colour persists for 30 sec. or more. A blank determination is carried out similarly, omitting only the epoxide, and, if the material is acidic, its equivalent weight is determined by a separate titration. If the first of these titrations is T, the blank B and the acid value of the sample weighed out A, all in terms of millilitres of decinormal alkali, then the percentage of pure epoxide in the material is given by the expression $\frac{(B + A - T)M}{100W}$, where M is the weight of pure epoxide containing 16 gm. of oxirane (epoxy) oxygen and W is the weight of material taken. Alternatively, the percentage of oxirane oxygen in the material is equal to $0{\cdot}16(B + A - T)/W$.

The dioxan–hydrochloric acid reagent should be prepared immediately before use, and the amount of hydrogen chloride used in an estimation should be at least twice that which is absorbed by the epoxide. A small beaker may be substituted for the weighing bottle, provided it is covered with a watch glass during the reaction; but dioxan absorbs carbon dioxide readily from the atmosphere, and when volatile liquids are under investigation a stoppered vessel is essential.

The following preliminary results illustrate the accuracy of the method, which compares favourably with that attained by using hydrogen chloride in anhydrous ether.

	Epoxide found (%)
Elaidic acid oxide, m.p. 55·5°	97·2
Oleic acid oxide, m.p. 59·5°	98·6
Ethyl oleate oxide, m.p. 21°	95·7
Epichlorohydrin, b.p. 118–119°	96·9

Pure oleic, elaidic (m.p. 44·5°), ricinelaidic (m.p. 52°) and dihydroxystearic (m.p. 95°) acids absorbed no hydrogen chloride under these conditions.

It is hoped to investigate the applicability of the method to other epoxides and to publish the results in further detail elsewhere.

G. King

Department of Biochemistry,
St. Mary's Hospital Medical School,
London, W.2.
May 17.

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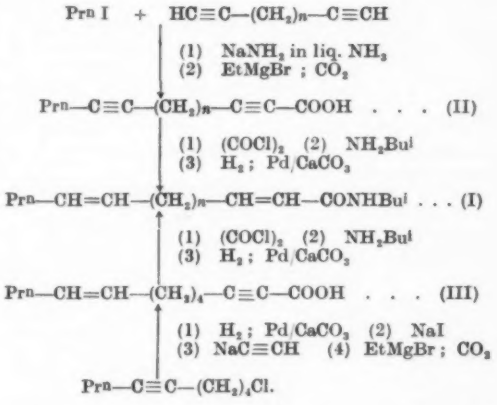
Synthesis of Geometrical Isomers of Pellitorine and Herculin

The announcement[1] of a paper entitled "The Synthesis of a Geometrical Isomer of Pellitorine", to be read by M. Jacobson at the 116th National Meeting of the American Chemical Society, prompts us to report similar work recently completed by us, and now in process of publication.

Compounds such as pellitorine (I, $n = 2$) and the closely allied herculin (I, $n = 4$) (configuration about the double bonds unknown) have aroused interest because of their potent insecticidal properties[2]. The substances I ($n = 2$ and 4) possessing the *cis* configuration about both double bonds have been synthesized by the methods indicated in the flow-sheet below ($n = 2$ for pellitorine and 4 for herculin), satisfactory yields being obtained in all stages.

The differential mono-alkylation of a diacetylene, followed by a condensation involving the remaining free ethynyl grouping, exemplified in the first two stages, constitutes a novel and flexible synthetic method of obtaining long-chain unsaturated aliphatic compounds with great ease. The diacetylenic acid II ($n = 2$) had m.p. 87°, and its *iso*butylamide had m.p. 72°. The corresponding diethylenic *iso*butylamide (*cis-cis* pellitorine; I, $n = 2$) was a liquid, b.p. 125–126°/5 × 10^{-4} mm., n_D^{26} 1·4856, in contradistinction to the solid natural pellitorine, which must, therefore, possess one of the three remaining geometrical configurations (*trans-trans*, *cis-trans* or *trans-cis*).


Prⁿ I + HC≡C—(CH₂)n—C≡CH
(1) NaNH₂ in liq. NH₃
(2) EtMgBr ; CO₂
Prⁿ—C≡C—(CH₂)n—C≡C—COOH . . . (II)
(1) (COCl)₂ (2) NH₂Buⁱ
(3) H₂ ; Pd/CaCO₃
Prⁿ—CH=CH—(CH₂)n—CH=CH—CONHBuⁱ . . . (I)
(1) (COCl)₂ (2) NH₂Buⁱ
(3) H₂ ; Pd/CaCO₃
Prⁿ—CH=CH—(CH₂)₄—C≡C—COOH . . . (III)
(1) H₂ ; Pd/CaCO₃ (2) NaI
(3) NaC≡CH (4) EtMgBr ; CO₂
Prⁿ—C≡C—(CH₂)₄Cl.

The diacetylenic acid II ($n = 4$) proved to be a liquid, b.p. 134–135°/10^{-2} mm., n_D^{16} 1·4882, and its *iso*butylamide had m.p. 47–48°. The diethylenic *iso*butylamide (*cis-cis* herculin; I, $n = 4$) was again a liquid, b.p. 145–146°/10^{-2} mm., n_D^{21} 1·4825, in contrast to the solid natural compound; the stereochemical difference already mentioned must, therefore, also obtain in this case. Alternatively, the *cis-cis* herculin may be obtained in a manner indicated in the lower part of the flow-sheet, the starting materials being 1-pentyne and 1-chloro-4-bromobutane. The ethylenic–acetylenic acid III, b.p. 116°/5 × 10^{-4} mm., n_D^{18} 1·4788, produced a liquid *iso*butylamide, b.p. 145–148°/10^{-2} mm., n_D^{18} 1·4876; on partial hydrogenation this yielded *cis-cis* herculin, identical with that obtained by the first route.

The structures of *cis-cis* pellitorine and *cis-cis* herculin have been confirmed by complete hydrogenation and oxidative degradation, when results identical with those recorded for the natural products[3] were obtained.

The various *iso*butylamides prepared are in process of being tested for insecticidal properties by the Agricultural Research Council. The synthesis of the remaining stereoisomers of I ($n = 2$ and 4) by various methods is now under investigation.

We wish to thank Sir Ian Heilbron for his interest in this work, which was carried out during the tenure of an I.C.I. Fellowship (R. A. R.) and a Senior Award of the Department of Scientific and Industrial Research (F. S.). We are also indebted to the Chemical Society for a research grant.

R. A. Raphael
F. Sondheimer

Department of Organic Chemistry,
Imperial College of Science and Technology,
London, S.W.7.
Aug. 31.

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Cross-Linking Reduced Animal Fibres

One of the more important aspects of the chemistry of protein fibres is the study of cross-linking reactions, each of which may be regarded as a potential process for industrial use. Low-temperature setting processes, for example, consist in cross-linking the mercapto groups of reduced wool fibres with oxidizing agents, metal salts or organic compounds containing two or more reactive halogen atoms in the molecule[1]. It has now been found that even more successful cross-linking of reduced fibres may be obtained with allyl *iso*thiocyanate, presumably because it is capable of combining with amino- and hydroxyl- as well as mercapto-groups[2].

After determining their load-extension curves up to 30 per cent extension in distilled water at 22·2° C., human hair fibres were reduced for 2 hr. at 50° C. in a molar solution of thioglycollic acid adjusted to *p*H 4·5 with potassium hydroxide[3]. The fibres were then washed in running water for 15 min., in *p*H 8 phosphate buffer for 15 min., followed by running water for 150 min. Some of the fibres were afterwards treated for 6 hr. at 50° C. with either 100 c.c. of the *p*H 8 buffer solution, or 2·5 c.c. of allyl *iso*thiocyanate suspended in 100 c.c. of either the buffer solution or water. Finally, all the fibres were washed in running water overnight before re-determining their load-extension curves in distilled water. From the two load-extension curves for each fibre, the percentage change in resistance to 30 per cent extension, due to the treatments, was calculated. The results are given in the accompanying table.

Treatment	Percentage reduction in resistance to extension
Reduced and washed	52·9
Reduced, treated with *p*H 8 buffer, and washed	29·7
Reduced, treated with allyl *iso*thiocyanate and buffer, and washed	9·2
Reduced, treated with allyl *iso*thiocyanate in water, and washed	10·3

Although allyl *iso*thiocyanate is so successful in strengthening reduced fibres, its use is likely to be limited because the cross-linkages are ruptured by 0·1 *N* hydrochloric acid in the cold and by a boiling 5 per cent solution of sodium bisulphite.

W. J. P. Neish
J. B. Speakman

Textile Chemistry Laboratory,
Department of Textile Industries,
University of Leeds.
May 29.

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Combustion of Droplets in a Fuel Spray

A fundamental investigation is in progress at the National Gas Turbine Establishment of the mechanism of the combustion of droplets in a fuel spray. In particular, the factors influencing the rate of burning, that is, the rate of evaporation of the burning drops, are being investigated. This preliminary note summarizes briefly some of the main results obtained to date, which are to be reported in full elsewhere.

Measurements have been made of the burning rates, in grams per second, of single drops of a series of commercial fuels and pure hydrocarbons. The experimental technique adopted has been to suspend a single drop of the fuel on a fine silica filament, and to measure with a cinematograph camera the rate of decrease in size during combustion in still air. Brief reference to this technique has already been made by Lloyd[1]. In addition to the above experimental investigation, a detailed theoretical analysis has been made of the mechanism of the burning process under these conditions.

The process of evaporation of a drop into an atmosphere of the same temperature has already been well investigated. Maxwell[2], Stefan[3], Sresnewski[4] and Morse[5] found theoretically and experimentally that the rate of evaporation, in grams per second, of a drop into still air is directly proportional to the first power of the radius of the drop, and to the difference in the vapour pressure at the surface of the drop and in the surrounding atmosphere. A detailed discussion of the process of evaporation under these conditions has been given by Fuchs[6]. Frössling[7] extended these results to the case of a drop evaporating in a moving air-stream of the same temperature.

During the process of combustion of droplets in a fuel spray, the difference in temperature between the drop and the surrounding atmosphere is, of course, considerable. So far as I know, there has hitherto been no published work dealing specifically with the factors governing the evaporation process of an individual droplet under such conditions. Reference should, however, be made to the work published recently by Wolfhard and Parker[8] on the evaporation processes occurring in a burning kerosine spray.

The results of the present investigations show that, in any event over the range of drop-size investigated (approximately 1,000–200 μ) and under the given conditions, burning drops also evaporate at a rate proportional to the first power of their radii. These results thus provide experimental justification for the assumptions used by Probert[9] in his mathematical analysis of the process of evaporation of a fuel spray. Further, the experimental results show that in the case of a burning drop the vapour pressure does not

have a predominant effect in determining the burning-rate. This confirms the views put forward earlier by Lloyd[1].

In the same paper, Lloyd suggested also that, in the case of a burning drop, the rate of evaporation would depend upon the rate of flow of heat to the droplet, and on the heat required to raise the temperature of the fuel to its boiling point and to evaporate it. The experimental and theoretical results of this present investigation confirm this view, and supply numerical evidence of the importance of the heat required to evaporate unit mass of the fuel in determining the rate at which a drop of that fuel will burn.

The theoretical treatment has led to an analytical expression for the heat transfer to the drop under the complex conditions of heat and mass transfer in the neighbourhood of the drop. Application of the expression for the heat transfer has enabled an explicit expression for the burning-rate to be derived in terms of the geometry and the physical properties of the system. Using the appropriate data so far available, theoretical values of the burning-rate have been calculated that are in good agreement with the observed values. The form of the expression for the burning-rate also enables predictions to be made concerning the effect of fuel characteristics (in particular, the heat necessary to evaporate unit mass) on the burning-rate, and these calculated results are likewise in agreement with those observed. Additional experimental information is at present being obtained in an endeavour to substantiate further the results of the preceding theoretical analysis.

I would like to express my acknowledgment and thanks to Mr. A. J. Colbourn for his assistance in the photographic techniques used in this investigation. Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this paper.

G. A. E. Godsave

National Gas Turbine Establishment,
Ministry of Supply.

April 11.

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Action of X-Rays on Nucleic Acids

For the understanding of the biological effects of ionizing radiations, it appears desirable to study their effects on relatively simple systems in aqueous media.

We have studied previously the action of ionizing radiations (X-rays, gamma-rays, neutrons, alpha-rays) on simple aromatic molecules (benzene, benzoic acid), where hydroxylation takes place, and phenolic bodies have been isolated[1]; and particularly on amino-acids (glycine, alanine, serine), where deamination has been found[2,3]. In view of the great importance of nucleic acids in biological processes, we have now commenced the study of the action of X-rays on nucleic acids in aqueous systems.

It has been shown by Mitchell[4] that one of the biologically significant actions of ionizing radiations is connected with nucleic acid metabolism. Greenstein *et al.*[5] have investigated the action of X-rays on sodium-thymonucleate and have observed physical effects such as a decrease in the viscosity of the solution; but they have not reported any chemical changes.

In order to study chemical effects and possibly to isolate some of the products of the irradiation, we have had to use relatively large doses of radiation. For example, 100 ml. of solutions containing up to 2 per cent of the sodium-nucleate were irradiated with doses of the order of 2 to 4 $\times$ 10^6 r. units, using —as in our previous work[1,2]—a specially adapted 200-kV. Victor Maximar set. Sodium-thymonucleate (B.D.H.) and sodium-ribonucleate (yeast) (B.D.H.) were used for these experiments, and the latter in particular was studied in greater detail.

We have found in every case that thymonucleic and ribonucleic acids in aqueous solution show some deamination by the action of X-rays, yielding ammonia. At the same time, one finds an additional increase in the van Slyke amino-nitrogen. Table 1 shows some of the figures obtained.

Table 1

Solution irradiated (100 ml.)	Approx. dose in r. units	Ammonia (millimoles/100 ml.)			Increase in van Slyke-N, millimol. per 100 ml. (after removal of ammonia)	Remarks
		Irradiated solution	Blank	Yield		
1 per cent Na-ribonucleate	2×10^6	0·064	0·009	0·056	—	*in vacuo*
1 per cent Na-ribonucleate	2×10^6	0·150	0·0095	0·140	0·11	in air
2 per cent Na-ribonucleate	4×10^6	0·302	0·068	0·234	0·25	in air
0·5 per cent Na-thymonucleate	2×10^6	0·0896	0·000	0·0896	0·05	in air

Although there is always a certain blank for the ammonia (which generally differs in the different commercial samples), the irradiated solutions show a very definite formation of ammonia (cf. Table 1), which is reproducible and is of the order of 0·1 millimole per 10^6 gram-roentgens. It is of interest to note that the yield in the presence of atmospheric oxygen is considerably greater.

The van Slyke amino-nitrogen determinations shown in column 6 of Table 1 give the difference between the blank and the irradiated solution. These results indicate a ring opening in the purine (or pyrimidine) ring of the bases. At the same time, we found also an increase in the amount of titratable acid as determined by titration with phenolphthalein and alkali. For example, irradiation of 100 ml. of a 2 per cent solution of sodium-ribonucleate with a dose of 4 $\times$ 10^6 r. yielded an increase of the order of 0·3 milligram equivalents of titratable acid groups. These positive results indicate that the nucleic acid molecule undergoes a profound chemical change under the influence of X-radiation.

Further experiments were thus concerned with the isolation and identification of any low-molecular fragments which might be formed. For the separation of these fragments from the nucleic acid, electrodialysis, through suitable 'Cellophane' membranes, has proved the most satisfactory method so far.

The irradiated ribonucleate solutions were electrodialysed at room temperature for 40–50 hours, with about 15 volts and with currents rising slowly to about 15 m.amp. Unirradiated blank solutions of the same samples were electrodialysed under exactly similar conditions. In this way, an increase in dialysable phosphate and also in inorganic phosphate (as determined by the method of Lowry and Lopez[6]) was observed in the positive pole section. The extent of this dephosphorylation is shown by the figures in Table 2.

Table 2. 100 ml. of 2 per cent sodium-ribonucleate irradiated with approx. 4×10^5 r. units (in the presence of air)

No.	Sample	Increase in PO_4^{3-} (millimol./100 ml.)
1	*BY* 1	0·016
2	*BY* 2	0·016
3	*BY* 3	0·014

The presence of *nucleotides* has not as yet been fully investigated, but some products of lower molecular weight have been found. From the negative pole of the dialyser, *bases* were obtained which could be precipitated by silver nitrate in acid solution (procedure of Kerr and Seraidarian[7]), and which were afterwards isolated as a mixture of the picrates. Under these conditions, one obtains the purine bases, and attempts are being made to identify the individual purine bases of this fraction. Preliminary experiments using the partition chromatography method of Vischer and Chargaff[8] have shown that one of these bases is adenine.

A second silver salt was obtained in alkaline solution (procedure of ref. 7). This fraction, after hydrolysis, gave a positive pentose test, and a small amount of bases could be isolated in the form of their picrates. This can be interpreted on the basis of the presence of a small amount of *nucleosides*. The same fraction contained also a substance which gave a strong Sullivan colour test, which is characteristic of guanidino compounds. This test was also given by the original irradiated solution, before electrodialysis (and after removal of ammonia).

The formation of ammonia under the action of X-rays is of interest, as it has been shown that this substance is capable of inducing (chemical) mutations[9].

The structure of nucleic acids is very complex and not yet fully known. Therefore any interpretation of our observations must necessarily be tentative only.

The results seem to indicate: (i) some fission of the glycosidic linkages with the liberation of purine bases; (ii) a deamination and ring-opening of the constituent bases; (iii) some breaking of the ester linkages, leading to the formation of inorganic phosphate; (iv) some splitting of the internucleotide linkages, which is partly responsible for the increase in titratable acid groupings. In all cases blank experiments under exactly similar conditions have confirmed that the effects described are solely due to the ionizing radiation.

The production of ammonia is also shown by irradiation with X-rays of guanine itself in an aqueous medium, when marked deamination takes place.

It has been shown in previous publications[10,1,2] that the mode of action of ionizing radiations on aqueous solutions can be interpreted as an indirect action involving hydroxyl radicals and hydrogen atoms which are formed from the water under the influence of the ionizing radiation. We have therefore studied the action of hydroxyl radicals produced chemically, by means of hydrogen peroxide and a ferrous salt (according to the reaction of Haber and Weiss[11]), on sodium-nucleates in aqueous solution, at room temperature. We have isolated (*a*) urea and guanidine from ribonucleate; (*b*) urea from thymonucleate. These products obviously correspond to a more far-reaching degradation than that observed in the case of X-rays. However, it is possible that in the case of irradiation with neutrons or alpha-particles, where the local density of the reactive hydroxyl radicals is much higher[12,13], products similar to those obtained by hydroxyl radicals produced chemically might be formed. Experiments on these lines are now in progress.

The irradiations were carried out in the Radium Department of the Royal Victoria Infirmary. We should like to thank Dr. F. T. Farmer and Mr. M. J. Day for their co-operation.

GEORGE SCHOLES
GABRIEL STEIN
JOSEPH WEISS

King's College,
University of Durham,
Newcastle upon Tyne.
June 27.

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Preparation of Titanium Esters

IN a recent paper, Speer[1] has described the preparation of a number of alkyl *ortho*-esters of titanium. We have also prepared such esters in these Laboratories by a number of methods[2].

The usual process consists of treating titanium tetrachloride with the appropriate alcohol and metallic sodium:

$$TiCl_4 + 4RONa = Ti(OR)_4 + 4NaCl,$$

and by this method we have obtained ethyl (b.p. 156°/16 mm.), *n*-propyl (b.p. 171°/14 mm.) and *iso*-butyl (b.p. 163°/13 mm.) titanates.

For the industrial production of these compounds, the use of sodium is precluded because of its cost. Moreover, the higher alcohols react only very slowly with the metal. However, by treatment of a suitable alcohol with titanium tetrachloride, followed by the passage of excess of dry ammonia, we have, in confirmation of the results obtained by Kraitzer, McTaggart and Winter[3], and in contrast to those of Speer[1], prepared several of these esters in very good yield, including ethyl, *n*-butyl (b.p. 189°/13 mm.), *iso*-butyl, *n*-amyl (b.p. 215°/12 mm.) and *n*-hexyl (b.p. 247°/14 mm.) titanates.

$$TiCl_4 + 4ROH = Ti(OR)_4 + 4HCl$$
$$4HCl + 4NH_3 = 4NH_4Cl.$$

The above processes fail with reactive alcohols, such as *tert.*-butanol. This compound does not yield the expected ester, owing to the fact that it reacts readily with any hydrogen chloride liberated during

the experiment, forming *tert.*-butyl chloride and water, the latter causing hydrolysis of any ester that might be present.

$$(CH_3)_2COH + HCl = (CH_3)_3CCl + H_2O.$$

However, by using pyridine to combine with the hydrogen chloride formed, and subsequent treatment with ammonia in excess, very satisfactory yields of such products as *tert.*-butyl (b.p. 114°/11 mm.) and allyl (b.p. 185°/12 mm.) esters can be obtained.

In general, these products are pale yellow, rather viscous liquids, readily hydrolysed in moist air. They are soluble in the usual organic solvents and do not, as stated by Speer, give precipitates with acetone or ethyl acetate.

A more detailed account of this work will be published elsewhere.

N. M. Cullinane
S. J. Chard

Tatem Laboratories,
University College,
Cardiff.
Sept. 6.

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Tropospheric Effects in Short and Medium Radio Wave Propagation

In a recent letter, Mr. D. W. Heightman[1] has given some interesting evidence for tropospheric influences on radio wave propagation in the short- and medium-wave bands. Some measurements made in July 1945 on wave-lengths in the range 60–300 metres confirm the existence of such influences. During the course of a programme of ionospheric eclipse observations conducted by the Radio Division of the National Physical Laboratory, at Loth (Sutherland), it was found that echo signals of appreciable amplitude appeared at ranges of 45 km. and 65 km. These signals could be identified as reflexions from mountains and were observed at all frequencies in the range 1–5 Mc./s. Amplitude measurements made each day over a period of a week established the following points.

(*a*) Although the amplitudes of the signals were often constant for periods of several minutes, or even hours, at other times the amplitude fluctuated considerably. When this fading occurred, it was similar to that observed for echoes from the ionosphere, the amplitude varying by a factor of 4 or 5 to 1 in a period of seconds.

(*b*) From regular observations made between the hours 0500 and 1900 G.M.T., no well-defined variation in mean amplitude could be deduced. On some frequencies there was a suggestion that the average echo amplitude was larger near midday than in the early morning, but this point could not be definitely established.

Throughout the experiments a close check was maintained on the output power of the sender and on the receiver sensitivity, and there seems little doubt that the observed fluctuations represented true tropospheric effects. It is probable that at these wave-lengths tropospheric effects are normally quite small and are not readily noticed except for ground-wave signals of small amplitude.

The work described above was carried out as part of the programme of the Radio Research Board, and this note is published by permission of the Department of Scientific and Industrial Research.

W. J. G. Beynon

Department of Physics,
University College,
Swansea.
Sept. 1.

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Velocity of Electromagnetic Waves

The recent applications of radar instruments to geodetic surveying have given great impetus to attempts to determine the velocity of propagation of ultra-high-frequency radio waves. In the United States Air Forces, an extensive project to utilize 'Shoran' for the precise measurement of geodetic distances was carried out in 1947. The distances measured varied from 67 to 367 miles in length. The project as a whole was directed by me, with valuable technical assistance in problems of propagational velocity and methods of adjustment by Donald A. Rice, U.S. Coast and Geodetic Survey. The reviewing board commented: "On the basis of the evidence submitted, however, it appears possible that the fundamental trouble may lie in an erroneous value for the velocity of light or for the dielectric constant of the air".

At that time, it was felt that to question the generally accepted determination by Anderson and others of 299,776 km./sec. would be presumptuous. However, in view of the recent corroborative evidence of Essen's[1] 299,793 km./sec., Bergstrand's[2] 299,796 km./sec. and Jones and Cornford's[3] 299,788 km./sec., it is now considered advisable to publish the value of 299,792 km./sec. as determined by me. The average deviation from the mean is $\pm 2{\cdot}4$, including all lengths of line. If line No. 1 is eliminated, the mean deviation of the remaining five lines is 1·0 km./sec.

The method of observation was to determine analytically the minimum sum distances between the two ground stations as an aeroplane flew across the line between the stations. The distances were corrected for the velocity of radio waves by a numerical integration along the ray path based on nearly simultaneously observed psychrometric observations. The velocity assumed in the design of the 'Shoran' computer was 299,776 km./sec. The sum distances were then reduced to the sea-level or approximate geodetic distances; an extensive system of triangulation by measured distances was built up by this method. A total of forty-seven lines was measured, varying, as previously stated, from 67 to 367 miles in length. A large number of redundant lines were incorporated and a rigid adjustment made by Rice's modification of the variation of co-ordinates method.

The velocity was deduced by two approaches. The first method was based on a comparison of the 'Shoran' measured distances with the six rigidly inversed lengths between four U.S. Coast and Geodetic Survey triangulation stations. The increments to the velocity of 299,776 km./sec. which had been assumed for the computer were computed to give values of the velocity which would best fit the inverse lengths, the relationship being,

$$\Delta V = \frac{\Delta S}{S} V_1,$$

where V is the velocity increment to be added to $V_1 = 299{,}776$ km./sec., ΔS is the geodetic distance subtracted from the 'Shoran' distance and S is the measured 'Shoran' distance. The accompanying table lists the results of this analysis.

Line	Inverse distance (st. miles)	S ('Shoran' measured distance using V_1)	ΔS ('Shoran'-inverse)	$^{\circ}\frac{\Delta S}{S} V_1 = \Delta V$	Deduced V_0 (299,776 + ΔV)	Deviation from mean
1	101·9344	101·9260	−0·0084	+24·7	299,800·7	+8·4
2	139·0629	139·0570	−0·0059	+12·7	299,788·7	−3·6
3	143·5987	143·5911	−0·0076	+15·8	299,791·8	−0·5
4	208·7428	208·7316	−0·0112	+16·1	299,792·1	−0·2
5	227·1442	227·1330	−0·0112	+14·8	299,790·8	−1·5
6	235·6710	235·6584	−0·0126	+16·0	299,792·0	−0·3
				Mean V_0	299,792·3	+2·4

$^{\circ}$ $V_1 = 299{,}776$ km./sec.

A second method of determining V_0 was to adjust the remaining 41 lines by a least squares adjustment, introducing a multiplier to determine the ratio of the increase in length of all 41 lines to produce the minimum correction in length to satisfy the adjustment. In this adjustment the four U.S. Coast and Geodetic Survey stations were held fixed in position and, therefore, the 'Shoran'-measured lengths over those lines were not introduced. The result of this adjustment gave a velocity identical with the velocity derived by the first method of 299,792·3 km./sec. The average deviation from the mean of the measurements of any one line whether all measurements were made on the same day or on a number of different days is ± 0·0014 mile, thus affording an indication of the consistency of the measurements.

The measurements extended over a period of three months, and the number of crossings made of each line varied from eight to sixteen. Four crossings, in a manner designed to remove observer's error, constituted a set of observations, and hence the crossings are in multiples of four.

A more detailed report on the methods is now in the process of preparation.

CARL I. ASLAKSON

U.S. Coast and Geodetic Survey,
Washington 25.
May 10.

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X-Ray Line-Breadths of Martensite

MAZUR[1], in a recent communication on the interpretation of the martensite X-ray diffraction pattern, does not mention the work of Wheeler and Jaswon[2], in which the conclusion was reached that the broadening was mainly a stress effect. It was found by them that when allowances were made for austenite line overlapping, and for the anisotropy of Young's modulus, the function $\beta \cot \theta$ was much more nearly constant than $\beta \cos \theta$, and, in fact, had almost the same value for the line *M*8 as for *M*2.

If their observed line-breadths are interpreted purely in terms of a supposed fineness of the martensite grains, the size of grains would only be about 20 A., which seems much too small to be reasonable[3]. On the other hand, the internal stress required to produce such broadening is about 90 tons per square inch, which compares well with the yield strength of martensite.

A formula similar to that quoted by Mazur has been adopted recently in this Department[4] for the analysis of experimental line-breadths. When applied to the results of Wheeler and Jaswon, a straight line of steep slope passing nearly through the origin is obtained, again indicating that the major factor contributing to the line-width is micro-stress.

Mazur's use of the Stokes Fourier analysis method[5] on some of his lines is most interesting, being apparently the first practical application of this technique. It would be very useful if the details of how the method was applied could be made known.

M. A. JASWON

Department of Metallurgy,
University,
Birmingham 15.

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The main problem of my investigations was the influence of very low temperatures on the physical properties of martensite and austenite. Temperatures as low as the temperature of liquid helium have not previously been used for the treatment of these constituents of carbon steel. The full report and experimental results will be published in due course.

It is well known that many authors attribute the extreme diffuseness of the X-ray diffraction lines of martensite to the existence of the 'small particle size' effect[1–5]. According to Wood[6], the predominant factor of the X-ray line broadening in a heavily deformed cold-worked carbon steel is also the small crystallite size.

The question of the grain size of martensite is still unsettled[6]. Westgren, Wever and Pfarr, and Clark[7] have obtained values for the grain size of martensite in steel which lie in the range 1 to 20×10^{-6} cm. Also Bragg[8], referring to the investigations of Sykes[9] and Jones on the copper gold alloy Cu_3Au, writes: "He has been able to produce a range of size varying from a diameter of about 40 A." (p. 106). Sykes and Jones state themselves: "The final result for the average size (t) was $5{\cdot}5 \times 10^{-7}$ cm., i.e., 14 atomic distances. Experimental determinations of this type are liable to errors of ± 30%" (p. 225). It may be of interest to point out that the apparent particle size of cold-worked molybdenum is about $0{\cdot}8 \times 10^{-6}$ cm.[10]. On the other hand, it is only below 10^{-6} cm. that broadening of the diffraction line is really sufficient for reliable measurements[11].

The results obtained by workers at Birmingham by applying a formula similar to that quoted by Mazur[12] show clearly that the influence of the small particle size on the broadening of the diffraction lines cannot be entirely neglected; the lines do not pass exactly through the origin, as Wilson's theory requires[13]. There may be, of course, minor fluctuations about these straight lines if the elastic constants are not isotropic or, in a special case, the crystal may approximate to some regular shape like a cube or octahedron[11]. In my investigations none of the lines passed through the origin; the average grain size was about 80 A.

The Fourier analysis method can be used in a special case not only to supplement the classical methods, but also it is the only method available for some particular specimens for which neither the Warren[14,15] nor the Jones[16] correction curve can be used[17].

I am in complete agreement with the opinion expressed by Wheeler and Jaswon[18] that the main factor causing the broadening of the lines is the internal stress; the same view has been held for some years by a number of Continental workers (Dutch, French and Polish).

JÓZEF MAZUR

Metallurgy Department,
Imperial College of Science and Technology,
London, S.W.7.

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New Method of Excitation of the Cometary Emission Bands at 4050 A.

UP to the present, two methods have been chiefly used for observing in the laboratory the 'cometary emission bands' at 4050 A. assigned to CH_2. Herzberg[1], who was the first to excite these bands, used an interrupted discharge through methane, and Herman[2] succeeded in photographing the bands with higher dispersion, using a discharge between carbon rods in an atmosphere of hydrogen diluted with a rare gas. The presence of the 4050 group was also reported in an ordinary discharge through diazomethane and ketene by Goldfinger, Le Goff and Letort[3]. No analysis of the bands has hitherto been attempted.

In order to undertake a more detailed study of these bands, we have developed a new method of excitation. We have used a graphite hollow cathode, operating at 500–1,000 V. with an intensity of about 200 m.amp. The 4050 group is strongly emitted in the hollow cathode discharge through various hydrocarbons (toluene, benzene, methane, even ordinary motor-oil), but it has been also possible to obtain a strong emission in pure hydrogen; this is of particular interest because it promises to give some valuable information concerning the molecules responsible and the conditions of their formation.

We have succeeded in photographing the main bands in an exposure of six hours with a 4·5 prism spectrograph in Littrow mounting giving a dispersion of 1·6 A./mm. at 4000 A. Even so, the resolution of the bands is far from being complete, but a well-developed Q-branch points to a convergency at 4051·4 ± 0·1 A. This origin corresponds approximately to the position of the strongest band of the group observed in cometary emission. Within the same band a relatively strong head measured at 4049·95 A. corresponds to another feature reported in certain cometary spectra. This last value corresponds also to the position of the head of the main band observed with smaller dispersion in the laboratory.

In the present stage of our investigation, it seems difficult to assume that the CH_2 radical is responsible for the band at 4051·4 A. Indeed, the moment of inertia deduced from the observed fine structure indicates a much heavier molecule.

It is worth while noticing, however, that in the spectra of some comets this band seems to have a behaviour different from the other bands of the same group. Therefore, the possibility of assigning it to a different molecule cannot be excluded.

We are now engaged in a more complete analysis of the whole system and in a study of the conditions of formation of the molecule responsible for it. We are also attempting to excite the corresponding bands in heavy hydrogen.

A full account of this work will be published elsewhere.

Note added in proof. The 4050 group excited in a graphite hollow cathode operating in deuterium showed no noticeable shift of the bands with respect to those excited in hydrogen. This is a new argument against their assignment to CH_2.

A. MONFILS
B. ROSEN

Astrophysical Institute,
University of Liège.
May 10.

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Quantum Mechanics of Canonical Field Variables

WITH the assumption that space is quantized according to the recent theory of Snyder[1] and Flint[2,3], the Fourier resolution of the vacuum electromagnetic field is not valid. Let us assume, however, that the field within a large cube is still describable in terms of an enumerable set of conjugate pairs of variables, q_λ and p_λ. In classical theory, there is a strong analogy between the q_λ and p_λ and the independent Cartesian co-ordinates and momenta of a set of particles each with one degree of freedom. Let us therefore assume further that the eigen-values of the q_λ are integral multiples of a small constant α, that those of the p_λ are continuous and, by analogy with Snyder's commutation relations together with the usual rule of quantum mechanics that variables belonging to different particles commute, that the commutation relations for the field are:

$$\left.\begin{aligned} [q_\lambda, q_\mu] &= 0, \\ [p_\lambda, p_\mu] &= 0, \\ [q_\lambda, p_\mu] &= i\hbar\{1 + \left(\frac{\alpha}{\hbar}\right)^2 p_\lambda p_\mu\}\,\delta_{\lambda\mu}. \end{aligned}\right\} \quad (1)$$

The solution for q_λ in a p-representation is

$$q_\lambda = i\hbar\left\{1 + \left(\frac{\alpha}{\hbar}\right)^2 p_\lambda^2\right\}\frac{\partial}{\partial p_\lambda}. \quad (2)$$

One may set up a Hamiltonian operator for the λ'th oscillator as in the Jordan–Pauli theory, the orders of non-commuting factors being chosen so as to avoid an infinite zero-point energy; and with the use of (2) and the omission of a term in α^4, one obtains the wave equation

$$\frac{1}{2}\left\{\left(1-\frac{v\alpha^2}{\hbar}\right)p^2-\hbar v^2\frac{d^2}{dp^2}-2v^2\alpha^2\left(p\frac{d}{dp}+p^2\frac{d^2}{dp^2}\right)-\hbar v\right\}\psi(p)=H_n\psi(p), \quad (3)$$

where v is the frequency corresponding to p, H_n is the n'th eigen-value of energy and the suffix λ has been dropped. Without the small term in $v^2\alpha^2$, (3) may be solved exactly, so that the effect of the term omitted may be computed by perturbation theory. The first four energy eigen-values are found to be

$$\left.\begin{aligned}H_0&=\frac{1}{2}\hbar v\left\{\left(1-\frac{v\alpha^2}{\hbar}\right)^{1/2}-1\right\}+\frac{1}{4}\alpha^2v^2,\\ H_1&=\frac{1}{2}\hbar v\left\{3\left(1-\frac{v\alpha^2}{\hbar}\right)^{1/2}-1\right\}+\frac{5}{2}\alpha^2v^2,\\ H_2&=\frac{1}{2}\hbar v\left\{5\left(1-\frac{v\alpha^2}{\hbar}\right)^{1/2}-1\right\}+\frac{561}{2}\alpha^2v^2,\\ H_3&=\frac{1}{2}\hbar v\left\{7\left(1-\frac{v\alpha^2}{\hbar}\right)^{1/2}-1\right\}+\frac{329,973}{8}\alpha^2v^2.\end{aligned}\right\} \quad (4)$$

The requirement that energy should be real necessitates the existence of a maximum frequency $\hbar/\alpha^2$. H_0 is a zero-point energy, and since v has an upper limit the total zero-point energy density is finite. For low v the description of the field is essentially in terms of quanta with energy differing only slightly from $\hbar v$. The small terms on the right of (4) increase non-linearly with n and appear to represent an interaction energy between the quanta. It might seem that the theory is not Lorentz-invariant, since energy is not proportional to frequency; but it must be remembered that since the field has no Fourier transformation there is no wave-number-frequency 4-vector.

A theory of canonical field variables analogous to that of quantized space thus leads to a 'cut-off' frequency, the existence of which has previously been postulated on a purely *ad hoc* basis for dealing with the divergence difficulty of quantum electrodynamics.

R. Cade*

Queen's University,
Belfast.
Feb. 22.

* Now at Dept. of Physics, University College of the West Indies, Jamaica.

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Mass of a Lorentz Electron

According to Heaviside (1885), as is well known, the rest mass m of a Lorentz electron, with radius a and charge e, is, in Gaussian units,

$$m=\frac{2e^2}{3ac^2}. \quad (1)$$

The mass m is obtained as the ratio of the magnetic energy in the field, assumed to be kinetic, when the electron moves with velocity v minute in comparison with c, to $\frac{1}{2}v^2$ (or rather to the limit of this ratio as v approaches zero).

I have recently learned that Heaviside's demonstration is not accepted as valid by everyone. Hence, it seems to me important to present another demonstration, which involves only momentum considerations, instead of energy considerations, to which alone the objections referred to apply. This demonstration has been used for many years in my lectures, but so far as my knowledge goes it has never been published and has never been used by others.

At any point P outside the electron and distant r from the centre, where r makes the angle θ with v, the electric and magnetic intensities E (radial) and H (normal to the plane of r and v) are

$$E=\frac{e}{r^2} \text{ and } H=\frac{ev\sin\theta}{cr^2}. \quad (2)$$

The Thomson electromagnetic momentum density at P is

$$N=[EH]/4\pi c,$$

the component of which in the direction of v is

$$N_v=EH\sin\theta/4\pi c. \quad (3)$$

With the values of E and H in (2), the integral of N_v throughout the electromagnetic field is

$$M=\frac{2}{3}\frac{e^2}{ac^2}\,.\,v. \quad (4)$$

The quantity N vanishes inside the sphere, where $E=0$, and the integral of its component normal to v vanishes outside the sphere. Thus M in (4) is the total momentum. Hence we may set M equal to mv, and obtain for the mass

$$m=\frac{M}{v}=\frac{2}{3}\frac{e^2}{ac^2}. \quad (5)$$

in agreement with Heaviside's result.

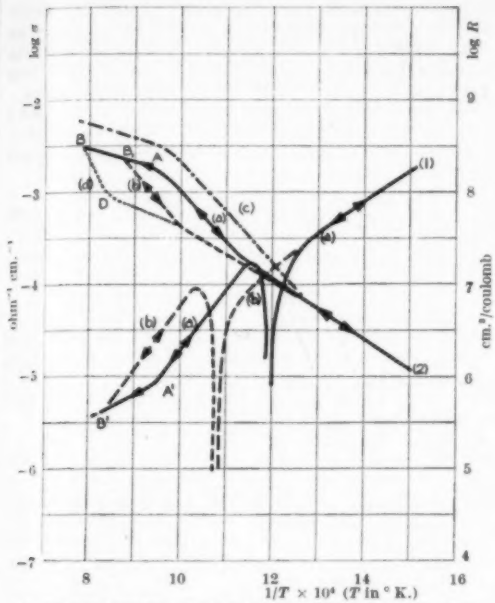
S. J. Barnett

University of California
and
California Institute of Technology.
May 11.

Hall Effect in Oxide Cathode Coatings

We have recently measured the Hall coefficient R and the conductivity σ in oxide coatings sprayed on a magnesia base. By drawing d.c. and pulsed thermionic emission, we have been able to activate the coatings satisfactorily, obtaining a d.c. work function near 1,000° K. of 1·0–1·2 eV., a pulsed work function of 1·2–1·5 eV., and a saturated pulsed emission at 1,050° K. of 4–5 amp./cm.². R and σ are calculated taking the observed mean thickness of the coating, with no correction for density, which is about unity.

In the double barium–strontium oxide, σ below about 850° K. is P-type, and log σ and log R both have slopes near 0·7 eV. when plotted against $1/T$, as shown in the accompanying curves. Near 850° K. there is a P—N transition, above which the slope of log σ is 0·8 eV., while the slope of log R is 1·1 eV. There is probably, therefore, a change of electron mobility with temperature in this range. The value of σ in this range depends on the activating procedure immediately before measurement, and curves (*a*) are typical of a moderately activated coating. Higher values are obtainable, as at (*c*), in higher current-density activation. There are considerable time changes following an activating treatment, especially above 1,050° K., which we believe are due to evaporation of free barium formed during activation. These changes lead to a marked temperature hysteresis; thus above the activating temperature a gradual



Hall effect and conductivity in oxide cathode coatings of BaO/SrO (40% BaO molecular): (1) Hall effect; (2) conductivity

temperature increase gives the section AB, with slope 0·2–0·3 eV.; but a rapid increase gives instantaneously the slope 0·8 eV., while a lowering of temperature, for example, after raising to the point B_1, gives again the slope 0·8 eV., as at (*b*), and this curve is reversible below the temperature B_1. The barium content is now lowered, as shown by the values of log R and the shift of the transition temperature. A whole family of curves can be obtained in this way, for example, (*a*) to (*d*). Thus the true slopes of log σ and log R for constant barium concentration are 0·8 and 1·1 eV. respectively. Below 1,050° K. the barium concentration does not vary with time appreciably, and the slopes always have the higher values. No doubt in the case of a coating on a metal containing reducing agents, the barium content is maintained at higher temperatures than with the insulating base, where activation occurs only during current flow.

In barium oxide alone, there is again P-type behaviour at low temperature, both log σ and log R having slopes of 1·1 eV. It is difficult to maintain a state of activation with the P—N transition below 1,100° K., and above the transition there is again a region showing large temperature hysteresis effects. Here the slopes of log σ and log R on cooling are 1·2 eV., but the slopes on heating are much lower. This indicates that in barium oxide a concentration of free barium is less readily built up and maintained than in the double barium–strontium oxide.

In a homogeneous semi-conductor, a P—N transition without an accompanying marked drop in σ could only occur in a transition from P-type to intrinsic conductivity. This cannot be so here, with a slope of log R above the transition as low as 1·1 eV. There must be two conductivities in parallel, and this is possible in the present case due to the porous structure of the coating[1]. It is possible that there is conductivity (i) through coating crystals and their contacts, which is P-type at the temperatures investigated, and (ii) over crystal surfaces and through pores in the coating, this being N-type, due to an electron atmosphere. In (*a*), the value of R indicates that the electron density n_e at 1,000° K. is 4×10^{12}/cm.³, and with a slope of log n_e estimated at 1·2 eV., the donator concentration n_0 is about 10^{17}/cm.³. Comparing curves such as (*a*) to (*d*), n_e is found to be proportional to σ, while it is known that $n_0 \propto n_e^2$; thus the highest value of n_0 we have encountered is about 10^{18}/cm.³. These figures seem to identify the donators with free barium, the concentration of which determined chemically is of this order[2]. If the above suggestion is correct, this free barium is also situated in pores and on crystal surfaces, as in earlier views on this subject, and not in the crystal lattice. This suggestion is supported by the agreement between the slope of log n_e and the thermionic work function, and by the large value of the mobility, 2,000 cm.² volt.⁻¹ sec.⁻¹, and of the mean free path, 2×10^{-5} cm.

The hole density in (*a*) is $2 \cdot 5 \times 10^{12}$/cm.³ at 1,000° K., so that the acceptor concentration is low, not more than 10^{14}/cm.³. The hole mobility is 200 cm.² volt^{-1} sec.$^{-1}$, and the free path 2×10^{-6} cm. There are, of course, many possible sources of acceptor impurity at this low concentration, while it is also possible that the holes are associated with barium deficiency in the lattice.

It is hoped to continue this work and to give a more detailed report later.

D. A. Wright

Research Staff, M.O. Valve Co., Ltd.,
at the Research Laboratories,
General Electric Co., Ltd.,
Wembley.
May 20.

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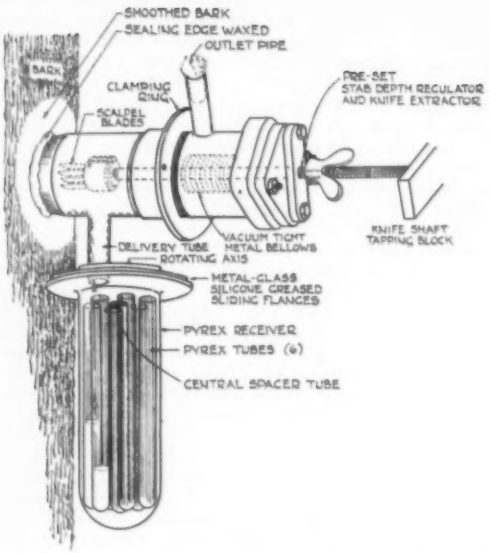
Extraction of Latex of *Hevea brasiliensis* under Sterile Conditions

The apparatus described in this note was conceived and developed during an investigation undertaken in Malaya with the object of obtaining samples of rubber latex from the living tree under completely aseptic conditions and in the absence of oxygen. This procedure is necessary for a fundamental study of the mechanism of natural coagulation and deterioration of latex which occurs on removal from the plant tissues under ordinary conditions.

Although the apparatus is highly specialized in its function, it is believed that workers in the field of latex research on *Hevea* and other plants which contain laticiferous vessels may find here the basis of a possible method of extraction of the contents of such vessels in a sterile and reproducible environment.

As the diagram shows, the main feature of the extractor is a steel body inside which the incisor or 'tapping' knives may be manipulated to penetrate the latex vessels while under vacuum-tight conditions. The whole apparatus, together with the receiver, is capable of being steam-sterilized in an autoclave in the usual manner. Once the instrument is attached to the tree, the operation of extraction is simple; but the technique of carrying out this former process under aseptic conditions requires practice for its successful operation.

The sealing edge and outlet pipe of the apparatus are plugged with cotton wool, the receiver is attached



to the metal flange with heat-resistant grease and the whole placed in an autoclave under 15 lb. of steam for an hour. A portion of the tree trunk about two inches in diameter is levelled with a spokeshave, care being taken not to penetrate the latex vessels during the process. This smooth, flat area is now washed with alcohol, which is then burnt off. Hot, molten paraffin-wax is immediately painted over the area in a thick layer. This is allowed to solidify and cool; meanwhile the sterile apparatus is temporarily adjusted on the tree, where it is held by a monkey-jack and chain clamping device (not shown) attached to the clamping ring indicated. A one and a half inch disk of wax is now removed from the centre of the prepared flat, the area is immediately washed again with alcohol, ignited, and the sealing edge of the apparatus exposed to this flame on removal of the cotton-wool plug. This edge is pushed through the burning alcohol on to the ring of wax and inserted therein to effect a temporary seal. The clamp is then tightened and a thick coat of hot wax painted around the outside of the seal to complete the operation. The tapping surface and interior of the apparatus should now be completely free from micro-organisms.

Appropriate arrangements are next made for the reception of the latex under the required conditions; for example, the apparatus may be connected to a field vacuum pump, manometer and nitrogen cylinder via the plugged outlet pipe and either simply evacuated or evacuated and filled with nitrogen. The effect of any subsequent oxidation of the latex is then easily observed in the laboratory. The latex may be collected into solvents, sterile buffer solutions, etc., or into the receiver cooled in a freezing mixture. When these preparations are completed, the knives are driven into the tree to a predetermined depth, which is regulated by means of the wing-nut shown. This nut is then used to extract the blades by a 'tightening-up' action. Latex immediately commences to flow from the incisions into the sterile receiver. In the extraction of rubber latex in Malaya, the collection was normally carried out under a slight positive nitrogen pressure. The receiver shown may be sealed off in a sterile condition by sliding it across the metal flange and under a sterile cover plate. This plate has a semicircle cut out of one edge, enabling it to fit closely around the metal flange during this transfer procedure. Alternatively, this receiver may be substituted by a 'pig' type which enables six individual samples to be sealed off in the field under the conditions of collection.

It is advantageous to select high-yielding trees for this type of sampling, as the amount of latex obtained from the small tapping area (four 1-cm. incisions) was found to vary from one half to one eighth of the total yield from the normal tapping panel, depending on the tree. Thus, 160 c.c. of latex were obtained by this means from a tree normally giving about 380 c.c. from a half-spiral tapping cut of about 30 in. in length, whereas from another tree which produces a more viscous latex the corresponding yield with the sterile instrument was only 40 c.c. Bacteriological examination of the samples collected showed them to be completely sterile.

Slight modifications to the design of the extractor are pending which will obviate the necessity for actual penetration of the bark by the sealing edge to obtain vacuum-tight conditions. This will be advantageous where the laticiferous tissues lie near the surface, as in the young tree.

The apparatus and technique described herein have been developed in the course of a programme of research on the latex and rubber of *Hevea brasiliensis* undertaken jointly by the Rubber Research Institute of Malaya and the British Rubber Producers' Research Association. I am glad to acknowledge the help of Mr. A. Walker in constructing the apparatus.

A. I. McMullen
Rubber Research Institute of Malaya,
Kuala Lumpur.

Suppression of Axillary Buds in the Tobacco Plant

In the commercial production of tobacco, large-sized and good-bodied leaves are usually required, and to achieve this farmers remove the terminal buds of the plants. This operation, popularly termed as 'topping', induces the development of axillary buds into 'suckers', which have to be removed to ensure the effectiveness of topping. The intensity of topping and the frequency of suckering (that is, removal of suckers) depends on the type of tobacco grown. Since the development of the lateral buds is irregular, the farmer has to keep a close watch continually and remove suckers periodically. The process is tedious, time-consuming and expensive. Experiments were, therefore, undertaken to develop methods which might result in saving labour and expense on suckering.

A simple method of suppressing the development of axillary branches after topping is to apply petroleum jelly to the dormant axillary buds immediately after the plant has been topped. A small quantity of petroleum jelly is smeared over the bud by means of a nickel spatula, and the treated buds wither away in a few days after the application. The effect of the application of jelly appears to be mainly physiological. The control plants in which the buds were injured by the spatula developed axillary branches with distorted leaves. Whether the jelly has some toxic effect, apart from the physical effect

of interfering with gaseous exchange, is under investigation.

This simple method has great practical utility, as its adoption will enable the farmer to reduce the cost of suckering or to do away with it entirely. The method may also enable the farmer to retain a larger number of leaves per plant without affecting their quality, as the buds are 'nipped' before they have any chance to develop into suckers. So far, all the varieties of tobacco tried, such as flue-cured (Harrison Special), bidi and cheroot, have responded uniformly to the treatment.

In addition to petroleum jelly, various mineral oils and fats, both of animal and plant origin, have been tried and found to suppress buds in varying degrees. Further investigation is in progress.

N. L. Pal
B. S. Kadam

Central Tobacco Research Institute,
Rajahmundry, India.
April 19.

Concretions in the Pyloric Gland of *Ciona intestinalis*

The pyloric gland has long been known to exist in ascidians and is recognized to be of general occurrence in the tunicates with the exception of the Larvacea, but its function has not been determined with certainty. The organ usually forms a system of branching and anastomosing tubules enveloping the rectum and part of the intestine, and opening into the gut between the stomach and the intestine by a single duct. Varicose swellings in the tubules are found in many genera. Chandelon[1], Isert[2], Sokólska[3], and van Weel[4], among others, believed the pyloric gland to be digestive in function, contributing enzymes to the intestinal contents. They based their conclusion on the presence in the walls of the tubules, of vacuoles which discharge into the lumen of the tubules. Todaro[5], Colton[6] Azéma[7] were among those who regarded the pyloric gland as an excretory organ.

Chandelon recognized solid refringent bodies in the terminal ampullæ of the gland in *Perophora*, and Isert found similar bodies in varicose swellings of the tubules in *Microcosmus*. Azéma also described concretions in the pyloric gland of *Dendrodoa*, *Ascidia* and *Ascidiella aspersa*. During the course of work on *Ciona intestinalis*, I have examined the pyloric gland, which was always found to contain solid bodies in the lumen of the tubules. These bodies occurred in most of the varicose swellings of the tubules either as a simple sphere or an aggregation of bodies of different sizes. The smallest spheres are solid, whereas the larger ones are apparently hollow shells. Throughout the life of the animal these bodies increase in number and size. When examined through crossed Nicol prisms, they appear bright with a black cross and are probably crystalline concretions built up in concentric layers. Chemical analysis of the concretions has not yet been attempted; but their physical structure suggests that they may be laid down as solid excretory products derived from the liquid secretion of the walls of the tubules.

It is of interest that a number of ascidians possess renal vesicles in which crystalline concretions of lamellar structure are deposited. *Ciona*, however, is among those ascidians which lack renal vesicles, and although nephrocytes in the blood appear to be responsible for some excretion, it is possible that the pyloric gland is the main excretory organ in *Ciona*.

R. H. Millar

Marine Station,
Millport.
May 10.

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Formation of Melanin in Regenerating Limbs of a Crustacean

The pigmentation of the isopod crustacean *Asellus aquaticus* is chiefly due to a melanin[1] distributed in granular form in the cytoplasm of stellate cells of the usual arthropod-type, underlying and interpenetrating[2] the epidermal cells. The newly eclosed regenerating limb is macroscopically unpigmented, and is very conspicuous. Microscopically, incipient pigmentation is sometimes visible, and otherwise becomes evident in a day or two, as golden-brown granules, in the cytoplasm of large wandering cells (17 μ or larger), at the time when these presumptive pigment cells first begin to assume their definitive position, and their asteroid form. These large wandering cells are a conspicuous feature of the newly eclosed limb, and decrease in number as pigmentation progressively develops, during the stadium following eclosion.

If newly eclosed regenerating limbs be amputated and placed in neutral[3] 1 per cent aqueous solution of 'Dopa', a visible dopase reaction appears, in half an hour, in the previously unpigmented wandering cells, and in cells in the early stages of fixation, at first near the fractured end of the limb, and afterwards spreading along. A black melanin is deposited within the cells (see photograph), which would thus appear to contain a specific concentration of an enzyme of the dopase group. Moreover, as in the ontogeny of animals (cf. ref. 5, p. 1,381), the active enzyme would seem to forestall the substrate, and regeneration might be said to recapitulate ontogeny.

Eventually, the 'Dopa' deposits as melanin in other tissues; first in the muscle fibres (see photograph), which become functional at eclosion, then in other cells of the blood[4], and eventually in the nuclei of the muscle syncytia and of other tissues. The epidermis is probably the least susceptible tissue, though the tonofibrils anchoring the muscles to the exoskeleton become impregnated. Exuviæ become

impregnated, but the new exoskeleton is at once too thin and, except immediately after ecdysis, too impermeable to show a clear reaction before that eventual non-specific deposition in all tissues which coincides with the appearance of evident spontaneous oxidation in the solution.

A dopase reaction has been demonstrated in the presumptive melanophores of the recently released young of *Asellus*, though these cells appear to be very few in number at any one time. Pigmentation develops gradually in these young animals which, like the newly eclosed regenerate, are very conspicuous meanwhile. The relatively late development of the protective coloration, in both, remains an interesting problem.

Fully pigmented non-regenerating limbs fail to give the reaction under the same conditions, the enzyme disappearing with the development of the natural pigment. The latter is readily distinguished from the pigment derived from 'Dopa' by its more golden-brown colour when viewed under the microscope.

Like the polyphenol oxidases of other invertebrates[3] and of other arthropods[6], the enzyme is incapable of oxidizing tyrosine itself. With the 'nadi' reagent a strong reaction is given by the muscles and by the nuclei of most tissues, but none of the free cells gives a clear reaction.

A similar specific reaction, with deposition of melanin in the presumptive melanophores of a regenerating limb, is, however, obtained with 5 : 6 dihydroxyindole, recently synthesized[7] in Prof. A. A. Robertson's laboratory, and would seem to lend further support to the view[8] that this substance is a transitory intermediary in the formation of melanin from 'Dopa'. The details of the reaction in general resemble those for 'Dopa', the muscles and other tissues later becoming melanic; but there are differences, some of which may be significant. Thus the colour of the pigment passes through purple to black, while 'Dopa' passes through slate-grey (possibly merely a *p*H difference[7]). Secondly, the reaction is much more rapid under the same conditions (2–10 min. as compared with ½–1 hr.). The spontaneous oxidation of the solution is correspondingly more rapid (complete in 2–3 hr. as compared with 2–3 days for pure 'Dopa'[4]). Thirdly, cells containing natural melanin are still capable of specific accumulation of more melanin from 5 : 6 dihydroxyindole. Further, stronger reactions are obtained with exuviæ, and with the 'liver' of the animal, than those due to 'Dopa' (possibly merely a difference in rate of deposition).

I am indebted to Prof. H. S. Raper for the gift of 'Dopa' and for advice, in particular for suggesting that 5 : 6 dihydroxyindole be tested, and to Prof. A. A. Robertson for the gift of this reagent.

A. E. NEEDHAM

Department of Zoology and
Comparative Anatomy,
University Museum,
Oxford.
May 24.

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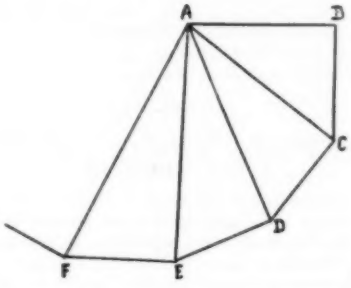
Rapid Calculation of Standard Deviations

A GRAPHICAL method, even simpler than that described by Woolf[1], of carrying out the major calculations in the determination of standard deviations can be suggested.

Suppose it is required to find the square root of the sum of the squares of the values a, b, c, etc. Draw AB equal to a, and by means of a graduated set-square mark the point C in a line perpendicular to AB at a distance BC equal to b. Place one side of the set-square along AC so that its apex is at C, and mark D at a distance from C equal to c. Proceed in the same way with the other values. Then $AC = (a^2 + b^2)^{1/2}$, $AD = (a^2 + b^2 + c^2)^{1/2}$, $AE = (a^2 + b^2 + c^2 + d^2)^{1/2}$, and so on.



If the number of values is large, the operations can be carried out on, say, ten or twenty values at a time, and the final hypotenuses can be combined in a similar manner, possibly after reducing them to a half or a quarter of their size.

In a modification of the above, it is unnecessary to mark the paper at all except for the initial point A. Place the set-square so that one side passes through A and the apex is at B, a distance a from A. Slide another set-square along the other side BC, leaving its apex at C, a distance b from B. Move the first set-square and place it so that one side passes through A and its apex touches the apex of the second set-square at C. Move the second set-square and slide it along the side CD of the first, etc.

By still another slight modification it is possible to obtain the mean graphically as well as the standard deviation. Let a, b, c, etc., be the 'positive' deviations from a value which in general is not the mean, and let a', b', c', etc., be the 'negative' deviations. Then in each case carry out the operations indicated in the drawing, but mark the points A, B, C, etc., with pins. Attach a piece of cotton to A, and simply pass it round the pins marking the figure $ABCDE\ldots$, measure the length in each case, obtain the difference, divide by the number of values, and use the resulting figure to correct the value from which the original deviations were taken. Each of the lengths will be slightly in error because of the curvature of the pins, but with a normal distribution the errors will tend to cancel out when the subtraction is made if the zero value is not far from the mean.

G. S. SMITH

Aeronautical Inspection Directorate,
Test House,
Harefield, Middlesex.
Sept. 6.

[1] Woolf, B., *Nature*, **164**, 360 (1949).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 24

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. Charity Waymouth: "Technique and Applications of Tissue Culture".* (Further Lecture on October 31.)

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Dr. H. P. Bayon: "The Development of the Experimental Method in Biology"; Dr. S. I. Tomkieieff: "The Anatomy of Geology".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Should Research in Electrical Engineering be Pursued mainly in Research Departments in Industry or should it be Transferred to Special Establishments ?" (to be opened by Prof. E. B. Moullin).

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the LONDON SECTION OF THE INSTITUTE OF BREWING, at the Horseshoe Hotel, Tottenham Court Road, London, W.1), at 6 p.m.—Prof. H. Lundin: "The Microbial Synthesis of Fats".

TEXTILE INSTITUTE (at 16 St. Mary's Parsonage, Manchester), at 6 p.m.—Mr. T. Ross: "Short Processing in Cotton Spinning".

Tuesday, October 25

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Rev. A. T. Welford: "Skill in Middle Age".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. G. E. Fogg: "Weeding with Chemicals".*

EUGENICS SOCIETY (at Manson House, 26 Portland Place, London, W.1), at 5 p.m.—Sir Godfrey Thomson: "Intelligence and Fertility, an Investigation of Scottish Children".*

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mr. G. W. B. Huntingford: "Chiefs and Ritual Experts in East Africa".

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. W. Thorp and Dr. W. C. Gilpin: "Chemical Engineering Problems in the Sea-Water Magnesia Process".

INSTITUTE OF WELDING (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6.30 p.m.—Mr. O. V. S. Bulleid: Presidential Address.

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. Frank A. Lowe: "St. Kilda—Epic of the Old St. Kildans—Britain's most Primitive Community".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. J. Hadji-Argyris: "New Methods of Aircraft Stressing".

Wednesday, October 26

INSTITUTE OF WELDING (joint meeting with the ALUMINIUM DEVELOPMENT ASSOCIATION, at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 11 a.m.—Dr. W. I. Pumphrey: "Welding of Aluminium Alloys—Value of Laboratory Tests"; at 6 p.m.—Mr. R. G. Braithwaite and Dr. D. J. Davies: "Welding in Bridgework and Allied Structures".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, CHEMICAL SECTION (at the Portico Library, Mosley Street, Manchester), at 5.45 p.m.—Mr. J. F. Straatman: "Some British Raw Material for Chemical Industry".

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL of the FOOD GROUP (joint meeting with the AGRICULTURE GROUP, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Dr. J. Hammond and Mr. R. H. Richens: "Genetic Factors affecting the Nutritional Value of Animal Products and Crops".

MANCHESTER METALLURGICAL SOCIETY (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. D. Binnie: "Problems raised from the Study of Steel Ingots" (Presidential Address).

BRITISH INSTITUTION OF RADIO ENGINEERS, WEST MIDLANDS SECTION (at the Technical College, Wulfruna Street, Wolverhampton), at 7 p.m.—Mr. W. Jones: "Television Receiver Design".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, Portland Place, London, W.1), at 7 p.m.—Mr. F. Twyman, F.R.S.: "Reflections on 50 Years in the Optical Instrument Industry".

Thursday, October 27

CHEMICAL SOCIETY, LIVERPOOL SECTION (in the Chemistry Lecture Theatre, The University, Liverpool), at 4.30 p.m.—Dr. R. S. Cahn: "Editing for the Chemical Society".

CHEMICAL SOCIETY, ST. ANDREWS AND DUNDEE SECTION (in the Chemistry Department, University College, Dundee), at 5 p.m.—Dr. J. S. Anderson: "The Chemistry of Metallic Oxides".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "Heteroecism" (to be opened by Dr. Malcolm Wilson and Dr. Edward Hindle, F.R.S.).

ROYAL INSTITUTE OF CHEMISTRY, MANCHESTER AND DISTRICT SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. G. N. Burkhardt: "Some Amine-Aldehyde Condensates" (Chairman's Address).

CHEMICAL SOCIETY, SOUTH WALES BRANCH (at University College, Cardiff), at 7 p.m.—Prof. C. K. Ingold, F.R.S.: "Aromatic Nitration".

BRITISH INSTITUTION OF RADIO ENGINEERS, SOUTH MIDLANDS SECTION (at the Technical College, The Butts, Coventry), at 7 p.m.—Mr. A. J. Tyrrell: "The Performance and Stability of Permanent Magnets".

Friday, October 28

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on "Energy Exchanges between the Sea and Atmosphere".

UNIVERSITY OF LONDON (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Prof. A. W. Ashby: "Britain's Land Economy".* (Further Lecture on November 4.)

UNIVERSITY OF LONDON (at Westminster Medical School, Horseferry Road, London, S.W.1), at 5.30 p.m.—Prof. V. Du Vigneaud: "The Indispensability of Biologically Labile Methyl Groups in the Diet and Transmethylation".* (Further Lectures on October 31 and November 2.)

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.15 p.m.—Dr. R. W. Bailey: "Steam-Gas Power Plant and Marine Propulsion" (Andrew Laing Lecture).

SOCIETY OF ENGINEERS (at 17 Victoria Street, London, S.W.1), at 6.30 p.m.—Mr. E. S. Waddington: Presidential Address.

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL GROUP (at the Albert Hall, Peter Street, Manchester), at 6.45 p.m.—Mr. T. A. Evans: "Operational Research and its Extension to Peace-time Industry".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (joint meeting with the CAMBRIDGE UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Laboratory, Pembroke Street, Cambridge), at 8.30 p.m.—Prof. A. Albert: "Chemotherapy and Essential Trace Elements".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. R. L. S. Bruce Mitford: "The Sutton Hoo Ship-Burial".

Saturday, October 29

SOCIETY OF LEATHER TRADES CHEMISTS, MANCHESTER GROUP (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. W. Cullen: "The Engineer, Engineering and the Tannery"; Dr. F. P. Stowell: "Lime".

BRITISH PSYCHOLOGICAL SOCIETY, SCOTTISH BRANCH (in the George Combe Psychological Laboratory, The University, Edinburgh), at 2.30 p.m.—Jean G. Wallace: "The Intelligence Testing of University Staff and Students"; at 4.15 p.m.—Dr. Boris Semeonoff: "Form Perception in Dark Adapted Vision".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. J. P. Mills: "The Meaning of Headhunting".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHIEF TECHNICAL OFFICER to the National Research Development Corporation—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.234/49BN (October 29).

SCIENTIFIC OFFICER to work on problems of animal nutrition, including those connected with the biological assay of vitamins and other factors—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (October 29).

SENIOR SCIENTIFIC OFFICER (with a good Honours Degree in engineering, or equivalent, and who should have studied the effect of static loads either in roads, airfields or foundations) at a Ministry of Supply Establishment in Southern England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting E.566/49BN (November 5).

CHIEF SUPERINTENDENT at a Ministry of Supply Engineering Establishment in Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.617/49BN (November 5).

LECTURER IN SOCIAL PSYCHOLOGY—The Registrar, The University, Leeds 2 (November 7).

EXPERIMENTAL RESEARCH ASSISTANT to carry out research under the direction of Prof. H. S. W. Massey on collisions of high energy electrons, positrons and quanta with atomic nuclei—The Secretary, University College, Gower Street, London, W.C.1 (November 7).

ENGINEER (II) at a Ministry of Supply establishment in Kent—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.360/49AA (November 11).

DEMONSTRATOR IN THE BACTERIOLOGICAL SECTION of the Department of Pathology and Bacteriology—The Registrar, The University, Leeds 2 (November 12).

SCIENTIFIC TECHNOLOGIST in the Coal Survey Laboratory at Birmingham—The National Coal Board, Establishments (General) Branch, Hobart House, Grosvenor Place, London, S.W.1 (November 14).

RESEARCH BOTANIST (with Honours degree) for research on certain aspects of frost damage to fruit trees—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (November 15).

SENIOR RESEARCH ASSISTANT, with experience of tissue culture or other experimental techniques, to study the biological reactions of connective tissue in the University's Rheumatism Research Centre—The Registrar, The University, Manchester 13 (November 15).

LECTURER IN PHYSIOLOGY in University College, Dundee—The Secretary of University Court, The University, St. Andrews (November 15).

INSTRUCTOR-EXAMINER IN RADIO AIDS TO MARINE NAVIGATION—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.250/49AA (November 15).

PUBLIC ANALYST AND OFFICIAL AGRICULTURAL ANALYST—The Town Clerk, Bournemouth (November 19).

REGISTRAR—The Deputy Registrar, University College of South Wales, Cathays Park, Cardiff (November 19).

ASSISTANT INSPECTOR OF SALMON FISHERIES—The Establishment Officer, Scottish Home Department, Room 364, St. Andrew's House, Edinburgh 1 (November 26).

READERSHIP IN ORGANIC CHEMISTRY at Birkbeck College—The Academic Registrar, University of London, Senate House, London, W.C.1 (December 8).

LECTURER or ASSISTANT LECTURER IN THE FACULTY OF RURAL SCIENCES, University College, Ibadan, Nigeria, in the following subjects: Tropical Agriculture, Agricultural Chemistry, Agricultural Zoology, Rural Economy, Animal Husbandry—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (December 15).

DEMONSTRATOR IN THE DEPARTMENT OF ENTOMOLOGY—The Assistant Dean, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1 (December 31).

POSTDOCTORATE FELLOWSHIPS for research in Pure Chemistry and Physics—The Secretary, Laboratories Awards Committee, National Research Council, Ottawa, Canada; or The Chief Scientific Liaison Officer, National Research Council of Canada, Africa House, Kingsway, London, W.C.2 (February 15).

ASSISTANT IN THE APPLIED SCIENCE DEPARTMENT—The Clerk to the Governors, Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton.

ASSISTANT EXPERIMENTAL OFFICERS in various Government Departments, and covering a wide variety of scientific (including engineering) qualifications—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2522.

LECTURER IN MATHEMATICS—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

FARM MANAGER IN THE VETERINARY DEPARTMENT, Nigeria—The Director of Recruitment, Colonial Service, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

ASSISTANTSHIP IN RESEARCH—Dr. N. Sheppard, Department of Colloid Science, The University, Cambridge.

ECONOMIC BOTANIST—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

METEOROLOGICAL OFFICERS (women holding an Honours Degree in Mathematics, Physics or Geography)—The Director, Women's Royal Naval Service, Admiralty, Whitehall, London, S.W.1.

STATISTICIAN to undertake a statistical analysis of the responses of tropical crops to fertilizers—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

EXPERIMENTAL OFFICERS to undertake critical statistical analyses of experimental and survey data—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

A List of Periodicals and Bulletins containing Abstracts published in Great Britain. (Prepared under the supervision of the Abstracting Services Consultative Committee: Issued by the Royal Society.) Pp. 62. (London: Cambridge University Press, 1949.) 2*s*. 6*d*. [48

Aluminium in Service. Pp. 84. (London: Aluminium Development Association, 1949.) 3*s*. 6*d*. [48

University of Liverpool. The Sherrington Lectures, 1: Sensory Integration. By Prof. E. D. Adrian. Pp. 20. (Liverpool: University Press of Liverpool, 1949.) 1*s*. [48

British Standard 1545:1949, Liquid Toilet Soap for General Purposes. Pp. 8. (London: British Standards Institution, 1949.) 1*s*. net. [48

Report of the Ministry of Health for the Year ended 31st March 1948, including the Report of the Chief Medical Officer on the State of the Public Health for the Year ended 31st December 1947. (Cmd. 7734.) Pp. xi+282. (London: H.M. Stationery Office, 1949.) 5*s*. net. [118

Pharmaceutical Emulsions and Emulsifying Agents. By Lawrence M. Spalton. Pp. vii+132. (London: *Chemist and Druggist*, 1949.) 5*s*. [118

Forty Years of Flight. By Lord Brabazon of Tara. (The Romanes Lecture delivered in the Sheldonian Theatre, 17 May 1949.) Pp. 16. (Oxford: Clarendon Press; London: Oxford University Press, 1949.) 2*s*. net. [118

The P.J. Poisons Guide: a Guide to the Pharmacy and Poisons Act 1933, the Poisons Rules and the Pharmacy and Medicines Act 1941, with an Extended Poisons List. Fifth edition. Pp. 46. (London: Pharmaceutical Press, 1949.) 3*s*. 6*d*.; interleaved, 4*s*. [118

I.E.S. Code for the Lighting of Building Interiors. New edition. Pp. 28. (London: Illuminating Engineering Society, 1949.) 2*s*. 6*d*. net. [118

British Standard 1559:1949, Reels and Drums for Bare Wire. Pp. 12. (London: British Standards Institution, 1949.) 2*s*. net. [118

Wool Industries Research Association. Publication 188: Report of the Director of Research for 1948–49. Pp. 24. (Leeds: Wool Industries Research Association, 1949.) [118

On Psychology To-day: an Inaugural Lecture delivered before the University of Oxford on 25 May 1949. By Prof. George Humphrey. Pp. 24. (Oxford: Clarendon Press; London: Oxford University Press, 1949.) 2*s*. net. [118

Twenty-seventh Report of Gresham's School Natural History Society, 1949. Pp. 48. (Holt: Gresham's School, 1949.) 2*s*. [118

Department of Scientific and Industrial Research. Report of the Building Research Board with the Report of the Director of Building Research for the Year 1947. Pp. v+49+20 plates. (London: H.M. Stationery Office, 1949.) 2*s*. net. [118

British Museum (Natural History). John Murray Expedition, 1933–34. Scientific Reports, Vol. 9, No. 2: The Littoral and Semi-Parasitic Cyclopoida, the Monstrilloida and Notodelphyoida. By Lt.-Col. R. B. Seymour Sewell. Pp. 17–200. (London: British Museum (Natural History), 1949.) 35*s*. [118

Air Ministry: Meteorological Office. Geophysical Memoirs, No. 84: Atmospheric Electricity during Disturbed Weather. By Sir George Simpson. Pp. 51+18 plates. (London: H.M. Stationery Office, 1949.) 3*s*. 6*d*. net. [118

Other Countries

United States Department of Commerce: National Bureau of Standards. Handbook 41: Medical X-Ray Protection up to Two Million Volts. Pp. vi+43. (Washington, D.C.: Government Printing Office, 1949.) 15 cents. [48

Field Museum of Natural History. Botanical Series, Vol. 13, Part 3, No. 2: Flora of Peru. By J. Francis Macbride. (Publication 622.) Pp. 50–778. (Chicago: Chicago Natural History Museum, 1949.) 2 dollars. [48

Research Council of Alberta. Report No. 52: Geology of Ribbon Creek Area, Alberta. By M. B. B. Crockford. Pp. 72. (Edmonton: King's Printer, 1949.) 50 cents. [48

Fondation Francqui, 1938–1948. Pp. 167. (Bruxelles: Fondation Francqui, 1949.) [48

Chicago Natural History Museum. Report of the Director to the Board of Trustees for the Year 1948. Pp. 138. (Chicago: Chicago Natural History Museum, 1949.) [48

Endogenous Endocrinotherapy including the Causal Cure of Cancer. By Dr. Jules Samuels. Seventh Circular. Pp. 32. (Amsterdam: Dr. Jules Samuels, Museumplein, 1949.) [48

Bulletin of the Geological Society of America. Vol. 60: Karroo Dolerites of the Union of South Africa. By Frederick Walker and Arie Poldervaart. Pp. 591–706+10 plates. (New York: Geological Society of America, 1949.) [48

Indian Central Jute Committee. Economic Research Memoir, No. 2: Economic Analysis of the American Market for Jute and Jute Manufactures. By D. Ghosh; with a Statistical Note on the Elasticity of Demand for Hessian in U.S.A., by K. C. Basak. Pp. iii+36. (Calcutta: Indian Central Jute Committee, 1949.) 1.4 rupees; 2*s*. [118

Rhode Island Agricultural Experiment Station. Contribution 703: 59th Annual Report. Pp. 56. Contribution 722: 60th Annual Report. Pp. 72. Bulletin 299: Rhode Island Weather. By B. K. Harris and T. E. Odland. Pp. 32. Bulletin 300: Optimum Soil-Nitrate Levels for Celery, Carrots, Spinach, Onions and Beets at Different Growth Levels. By John B. Smith and Milton Salomon. Pp. 28. Bulletin 301: The Providence Milk Market. By J. L. Tennant. Pp. 54. Bulletin 302: Acceptability and Ascorbic Acid Content of Frozen Rhode Island Vegetables. By Ruth E. Tucker. Pp. 24. Bulletin 304: The Use of Kitchen Utensils in Rural Rhode Island Homes. By Blanche M. Kuschke and Grace H. Smith. Pp. 28. (Kingston, R.I.: Rhode Island Agricultural Experiment Station, 1947–1949.) [118

Smithsonian Institution: United States National Museum. Bulletin 196: Life Histories of North American Thrushes, Kinglets and their Allies; Order Passeriformes. By Arthur Cleveland Bent. Pp. viii+454+51 plates. (Washington, D.C.: Government Printing Office, 1949.) 1.50 dollars. [118

Smithsonian Institution: Institute of Social Anthropology. Publication No. 9: The Terena and the Caduveo of Southern Mato Grosso, Brazil. By Kalervo Oberg. Pp. vi+72+24 plates. (Washington, D.C.: Government Printing Office, 1949.) 60 cents. [118

United States Department of Agriculture. Farmers' Bulletin No. 1911: Preventing Damage to Buildings by Subterranean Termites, and their Control. Revised edition. Pp. ii+38. (Washington, D.C.: Government Printing Office, 1949.) 15 cents. [118

Federal Security Agency: Office of Education. Biennial Survey of Education in the United States, 1944–46, Chapter 2: Statistics of State School Systems, 1945–46. By David T. Blose. Pp. vi+96. 25 cents. Bulletin 1949, No. 1: Education in Bolivia. By Raymond H. Nelson. Pp. vi+90. 25 cents. (Washington, D.C.: Government Printing Office, 1949.) [118

Scandinavian Journal of Clinical and Laboratory Investigation. Edited for the Scandinavian Society for Clinical Chemistry and Clinical Physiology. Quarterly. Vol. 1, No. 1. Pp. 86. (Oslo: Medisinsk Fysiologisk Forenings Forlag, Rikshospitalitet, 1949.) 30 kr. per Vol. (4 issues.) [118

Catalogues

Rohm and Haas Reporter. Vol. 7, No. 2, April. Pp. 26. (Philadelphia: Rohm and Haas Company, 1949.)

Muirhead Technique: a Journal of Instrument Engineering. Vol. 3, No. 3, July. Pp. 17–24. (Beckenham: Muirhead and Co., Ltd., 1949.)

S.E.I. Photocells. Pp. 16. (Salford: Salford Electrical Instruments, Ltd., 1949.)

Laboratory Fittings. (Publication No. 518.) Pp. 4. (London: A. Gallenkamp and Co., Ltd., 1949.)

Plant Growth Substances. (List No. 4.) Pp. 12. (London: PAL Chemicals, Ltd., 1949.)

Price List of Quality Laboratory Glassware and Thermometers. Pp. 32. (Pontypridd: H. J. Elliott, Ltd., 1949.)

Service to Science, No. 17: The Research Model Constant Temperature Bath. Pp. 4. Service to Science, No. 18: The New T. and M. Range of Ovens. Pp. 4. (London: Townson and Mercer, Ltd., 1949.)

Bibliography, History, Atlases and Maps, Printing, Archaeology and Folklore, Costume, Economics and Sociology, Palaeography, etc. (Catalogue No. 698.) Pp. 130. (London: Francis Edwards, Ltd., 1949.)